the length of the line, and with Vignoles rails at each length of 250 m. places an ordinary joint to ease the effects of expansion and

30,779. "Improvements in electric arc lamps." J. A. Heany. Dated November 17th. (Complete.)

THE

ELECTRICAL REVIEW.

Vol. XLVII. DECEMBER 7, 1900. No. 1,202.

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THE

UNIVERSAL ELECTRICAL DIRECTORY

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ELECTRIC RAILWAY STANDARDS.

One of our correspondents this week—whose signature is not one that can be lightly passed over—draws attention at a very appropriate moment to a consideration of the most vital importance to the British Electrical Engineering industry. As the opening of the new century draws nearer, so, too, there is dawning upon us a new era in railway working, aptly styled by Mr. Langdon in his recent paper "The Supersession of the Steam by the Electric Locomotive." That paper is dealt with elsewhere in this issue; our present purpose is to consider, not whether the change *can* be made—of that we are satisfied—but *how* it should be carried out.

Owing to the enormously rapid progress of electric tramway enterprise in America, where it was free to expand unfettered by those vexatious limitations formerly imposed upon such projects in this country, and, to a less extent, on the European Continent, it was practically inevitable that, when we were allowed to go ahead, American practice should exercise a very large influence over our nascent systems of electric tramway construction. Moreover, owing in great measure to the apathetic attitude of our leading electrical firms, and to the energetic policy of the large American agencies, it has come to pass that the standards in vogue in the United States have become unalterably incorporated in our tramway systems, although every detail employed in tramway work can now be obtained of British manufacture. In some respects there is nothing to be said against the American methods, but, on the other hand, as we have previously pointed out, many objectionable features have been thoughtlessly adopted, greatly to our disadvantage.

Now, in the matter of electric railways, the case is entirely different. We can boldly claim to be the pioneers in electric railway construction, both underground and overhead, and no country has gained a lead over us such as obtained in the case of electric tramways. If we display the energy that is necessary for the maintenance of our commercial pre-eminence, we shall not allow ourselves to be outstripped in this respect.

We stand, as Mr. Tyler points out, on the very verge of an immense departure from long-established systems; at no distant date our railways will be worked entirely by electricity — first the busy networks of suburban districts, then important local lines between large neighbouring towns; finally, perhaps, the great trunk mains. It is supremely essential that this great work shall not be hampered and thrown back by the too hasty adoption of unsuitable systems and apparatus; the greatest care and forethought must be exercised to ensure that every step shall be forward, and none backward. To this end we must approach the question with open minds, ready to weigh impartially, and with the utmost deliberation, all possible means of carrying out the conversion.

On Monday last the Joint Electric Traction Committee of the Metropolitan and Metropolitan District Railway Companies opened the tenders submitted to them for the electrification of their railway systems; upon them an immense responsibility devolves. Whatever choice of system they may make is certain to exert the greatest influence upon the future development of similar undertakings, and it is for this reason that we have thought it necessary to insist on the moral of Mr. Tyler's warning, and to point out the

D

of the switch produces no deflections. The amount of the adjustable resistance

clockwork mechanism. 11 claims.

supreme importance of this, the first, conversion from steam to electricity in this country.

In the first place there can be no doubt that we must cut loose entirely from electric tramway methods. There is absolutely no parallel between the two cases; yet it is more than likely that some propositions will be made, more or less based upon tramway practice. A tramcar runs on the public roadway, common to all kinds of traffic; stops at frequent intervals—in some cases at the nod of a would-be passenger; never attains a high speed; never (in this country) goes far from its base. A railway train, on the other hand, runs over private property, from which all other traffic is excluded; stops at far longer intervals, and only at set stations; attains the highest possible speed between stops, and must cover long distances.

Now, the standard 500 volts of tramway practice is quite unsuitable for railway work. The distance of transmission is greater, as well as the distance between successive trains, so that the line is longer, and the copper less usefully employed; the power to be transmitted is far greater, therefore also the current, unless higher pressures are utilised. The capital outlaid on distributing mains will be one of the most important factors in the case of an electric railway, and it *must* be kept down to the utmost.

Further, the series parallel method of control has been relied on for economical working in starting cars; but in stopping them, the kinetic energy stored up is dissipated in friction. This will never do for railway working. We would here point out that it is useless to adduce the Central London Railway as a case in point to the contrary. The circumstances are entirely different. The gradients of the C.L.R. were carefully chosen, so as to immensely aid the economical starting and stopping of the trains, with wholly admirable results; but the gradients of existing underground railways, and of all surface railways, cannot be altered—they must be taken as they are. Now, if the system of control in use on the Central London Railway were adopted on a surface railway, the locomotives would be found to be far too small, and the current at starting would sometimes be four or five times the normal—for trains often have to start and get up speed on up-grades. Moreover, the heavy existing rolling stock must be utilised, and the retardation-gradients, by which so great a saving of energy is accomplished on the C.L.R., would be absent. We have, then, a heavy train to be started quickly and brought up to a high speed, thus storing up an amount of energy quite out of proportion to the amount spent in overcoming friction; for successful working on, say, a suburban line, the greatest possible proportion of this kinetic energy must be restored to the system. This can be done by converting the motors into dynamos *pro tem.*, delivering power to the lines, not merely at high speeds, but down to the *lowest possible limits* before friction braking becomes necessary. Means are available for this purpose, some of which our readers are already acquainted with, while others are as yet unpublished.

Again, such a method of collection must be adopted as may be readily applicable to crossings and sidings of the most complicated description; it is of no use to say "Use steam locomotives for shunting"—if the train, or *a single locomotive* cannot be electrically propelled throughout any network of sidings, the system is not fit for adoption.

The use of the three-wire system, as applied on the City and South London Railway by Mr. McMahon, or some modification thereof, must be seriously taken into consideration, and it will probably be found to be necessary to insulate the lead and return conductors throughout their length—but not on account of the magnetic observatories.

The three-phase system, we maintain, is entirely unsuitable for suburban traffic, on the score, not of starting torque or power factor, but of energy conservation. With the frequent stops and starts inherent to such traffic, the waste of energy in getting up speed and the impracticability of restoring energy to the line in braking would be fatal to an alternate current system. Be it remembered that induction motors can only act as generators when running at a *higher* speed than that of synchronism, and without an efficient variable speed gear this condition cannot be obtained while the train is slowing down.

For main line traffic the three-phase system is, however, admirably adapted—indeed, there appears to be no other means of electrical propulsion nearly so suitable for this purpose, with long runs at constant speed and few stops.

Returning to the main question, we foresee a danger that the engineering aspect of this most important undertaking—with especial reference to the Metropolitan railways—may be subordinated to financial operations. Already there are ominous signs of such transactions. We hope the matter will be dealt with on broad lines, and with the determination to discover the best possible solution—otherwise irrevocable and lasting injury will ensue to the development of electrical railway engineering in this country.

Electric Tramway Statistics.

Accompanying the present issue, readers will receive our annual sheet of electric tramways and railways in the United Kingdom. To give particulars of the many other systems which are about to be equipped, or where work has just been commenced, would occupy so much space as to make the list of unwieldy proportions; we have, therefore, for the most part, confined ourselves to lines which are in actual operation. We take this opportunity of expressing our indebtedness to tramway managers, electrical engineers, and others who have so readily come to our assistance in the compilation of this table, and we trust that they will find the material of some value for reference purposes. It will be observed that the present sheet contains a good deal more data relating to costs per car-mile and ratio of expenses to receipts than it was possible to include in our last list, published 12 months ago. It is such figures as these that tell very forcibly in clearing away any apathy which may still exist among tramway authorities in regard to the subject of electric traction. We know for a fact that the information given under these headings in our 1899 list was employed as a very successful weapon by some. With the disappearance of the Birmingham lines from the list, there also disappears, for the time being, at any rate, the only battery system of which this country has latterly been able to boast. This section is now changing to overhead trolley, therefore all English electric tramways now in operation are on the trolley method. Twelve months ago we recorded the fact that the London County Council had voted large sums for surface contact and underground conduit tramways. How terribly bound up our latter-day civilisation is with red tape and legislative requirements, is realised when one repeats that, what we said last year, practically represents the position of things to-day. It is true that at last the Council's expert engineer has specially devised an underground conduit system, which has been approved by the Highways Committee, but this has even yet to be submitted to the Board of Trade, and to the local authorities whose districts are affected under the proposed schemes. Perhaps early in the next century practical work will actually be proceeded with. In the promotion of new schemes for electric tramways and underground railways, there has recently been great activity. The rush of the promoter in connection with underground electric lines for London amounts practically to a boom. The new projects are very numerous, but so far they are *only* projects. They have yet to pass through many an ordeal before very serious thought need be paid to them. Is there not a danger of overdoing the thing? The coming electrical equipment of a hundred odd miles of tramway in South London, the conversion of the Metropolitan underground, and the construction of a number of other electric tunnels—these all indicate that it is now becoming generally realised that in electricity is to be found a solution to the modern traffic-handling problem in crowded cities. Electrical engineers have endeavoured to drive this truth home for many a day; the progress they sought has come all too tardily. Now that it has really come, English electrical engineers should do all that is within their power to ensure the adoption of English work and English machinery and material. With the closing of the old century they must buckle their belt the tighter for a hand-to-hand encounter with Continental and American rivals. They cannot afford the humiliation of being worsted in the contest. Having found their feet let them stand against all comers.

SOME NOTES ON THE DESIGN OF LARGE ALTERNATORS.*

By A. HEYLAND.

The principles underlying the construction of modern types of large alternators of the fly-wheel class, are nowadays quite definite, and a reference to the collection of large machines exhibited at the Paris Exhibition, by nearly every electrical firm of standing in the world, illustrates how the design of such generators has been standardized, for there is not a single machine among the collection that shows any important novelty. But, although this is certainly the case, yet the writer cannot agree with a certain well-known electrical engineer, who has stated that all the alternators exhibited are practically identical, for an examination of the details of these machines shows that there are great differences in the actual design. Machines having the same rating, under the same conditions of service, differ widely with regard to weight and dimensions, showing that the materials used in their construction are utilised to better effect in some cases than in others.

The two 3-phase alternators exhibited at Paris by Messrs. Electricité & Hydraulique (of Charleroi) and designed by the writer, differ widely from other alternators exhibited, not so much in external appearance, as in their electrical design and performance. So far as the writer knows, no machines of the type in question have hitherto been built having such small pressure drops; by "pressure drop" is meant the fall in pressure per phase at full load at constant speed and excitation—one of the most important points connected with the design of large alternating current generators. In other respects, too, the tests which have been made on these machines clearly demonstrate that the principles underlying the design of such machinery, as laid down by the writer some time ago, are those which it is necessary to adopt if the best results are to be obtained. The excellent results obtained with the alternators in question are due, firstly, to various electrical details which will be discussed below, but principally to the *high magnetic saturation* in the poles; combined with very small magnetic leakage—or rather, with a very small increase of magnetic leakage from no load to full load.

Fly-wheel alternators can be broadly divided into two classes, viz., those in which stability of the stationary armature frame is increased by radial arms in tension (Brown-Boveri type), and those in which the armature frame takes a U-shaped form, the machine being consequently of large external diameter, but of small width. The machines exhibited by the writer's firm belong to the latter class, the form in question being of considerable advantage where space is very limited, as, for instance, between the cylinders of two-crank engines; moreover, the construction itself is more of the nature of a fly-wheel construction.

The two alternators referred to above differ but slightly; each machine is of 750 kw., and is driven by a horizontal two-crank engine, the alternators and exciters being mounted between the cylinders. The alternator exhibited in the French section (hereinafter called Alternator No. 1) generates a current of 200 amperes per phase at 2,200 volts per phase and 50 cycles when running at 94 revolutions per minute, while that exhibited in the Belgian section (hereinafter called Alternator No. 2) generates the same amount of current at 2,200 volts per phase, but at 42·5 cycles, it running at 80 revolutions per minute. Both the machines have star connected armatures with hole windings, the field coils being wound with copper strip in each case.

Fig. 1 gives a good idea of the construction and general arrangement of each of these machines; it represents a portion of Alternator No. 1. That the distribution of the building material is excellent may be seen when the weights

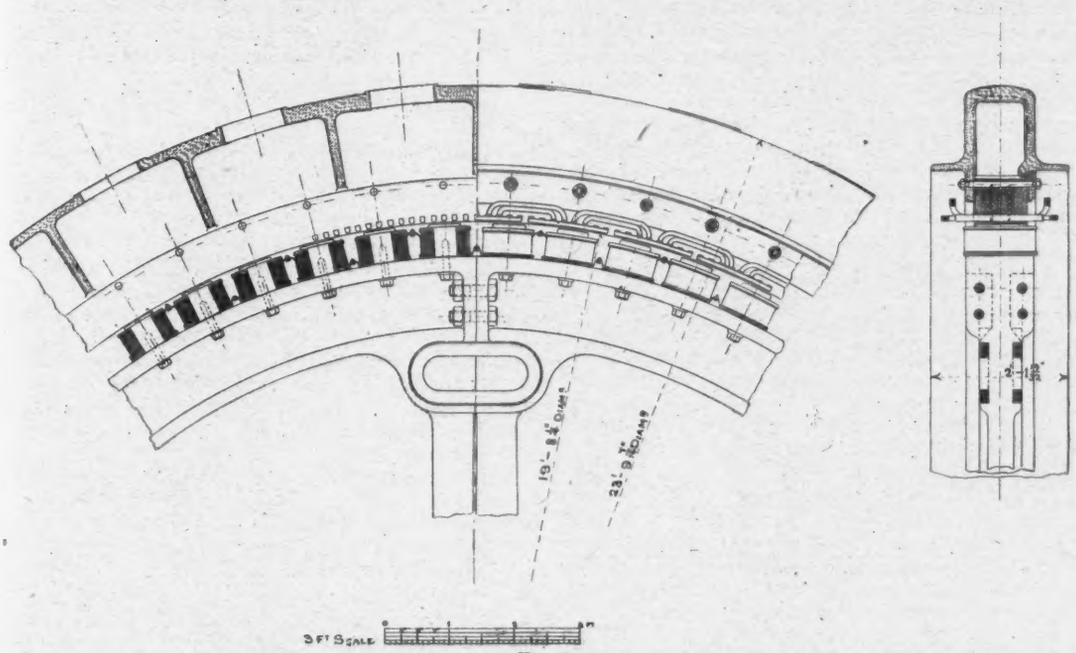


Fig. 1.

are considered. Thus, with this machine, the weight of the complete fly-wheel is 20·2 tons (copper 4,400 lbs.), and that of the armature and frame is 22 tons (copper 1,100 lbs.), thus making a total weight for the complete machine, without the shaft or bearings, of 42·2 tons. This gives a weight of 126 lbs. of total material per kilowatt, of which 7·3 lbs. is copper. The 1,000 b.h.p. Weyher and Richemond compound engine driving this generator has, with the above fly-wheel, a variation of angular velocity in one revolution at constant load not exceeding 0·5 per cent., the kinetic energy of the fly-wheel, $\left(\frac{M V^2}{2}\right)$, being 6,350,000 foot-pounds.

A noteworthy feature of these generators is the construction and dimensions of the field poles; these latter are bolted directly to the rim of the magnet wheel without being let in in any way, as is frequently done, in order to decrease the magnetic resistance between the two surfaces; there is no reason for such a construction with these machines, as the magnetisation of the iron is carried to a very high value, and the paths for the lines of force are very short, so

*These notes have special reference to tests made on the alternators of 1,000 b.h.p., exhibited by The Electricité et Hydraulique, Limited, of Charleroi, at the Paris Exhibition.

that the air resistance has but a small influence on the magnetic resistance. The poles themselves (the pole shoes are cast with them), are unusually short, in order to minimise the magnetic leakage between them ; moreover, the leakage path is still further lengthened, owing to the fact that the poles are of comparatively small section, the reduced section being possible on account of the high flux density in the poles, and on account of the high permeability of the cast-steel employed.

As already stated, the armature windings are carried out in closed slots, the depth of these slots being made small, in order to reduce as much as possible the magnetic leakage that occurs in the teeth between them ; the closing of the slots, on the other hand, of course, has the effect of causing considerable magnetic leakage of the flux from the poles across the slot bridges, which, with these machines, are about $\frac{1}{12}$th inch deep, but it must be remembered that this leakage will not alter much with the load. If the slots were open, the leakage field would depend on the magnetic resistance of the gap across the slots, and it would vary with the ampere-turns of excitation, and consequently, would change with the armature current. But, owing to the fact that these bridges are present, there is at every load a strong leakage across them, to such an extent that already at no load (with excited magnets) the bridges are saturated, and, therefore, the magnetic resistance is constant.

The air-gap lengths (iron to iron) are respectively 0·395 inch and 0·315 inch in Alternators Nos. 1 and 2, the diameter of the armature bore being 236 inches in each case. On account of these large air-gaps, it is a somewhat difficult matter to obtain the high flux densities in the poles, whose use is advocated by the writer, without an unduly large excitation. For smaller machines, where relatively smaller air-gaps are permissible, it is easier to apply these principles, the flux density being perfectly easily obtained with normal field excitation. However, an examination of the figures given below relating to the two alternators in question will show exactly what can be attained in practice.

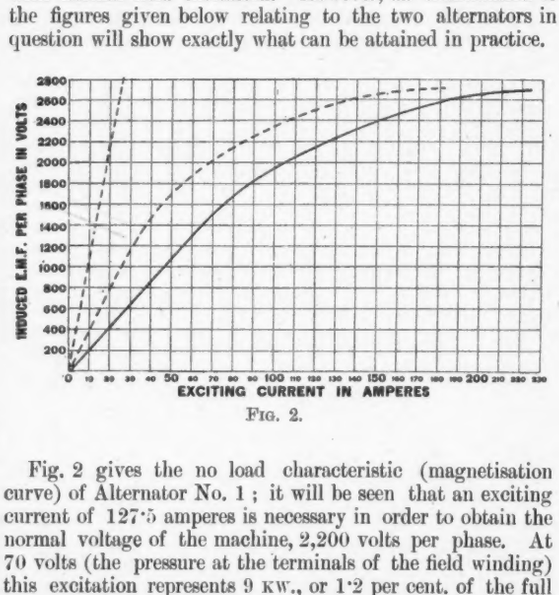


Fig. 2.

Fig. 2 gives the no load characteristic (magnetisation curve) of Alternator No. 1 ; it will be seen that an exciting current of 127·5 amperes is necessary in order to obtain the normal voltage of the machine, 2,200 volts per phase. At 70 volts (the pressure at the terminals of the field winding) this excitation represents 9 kw., or 1·2 per cent. of the full load output. The point indicating the normal voltage of the alternator will be noticed to be well over the knee of the curve, and after this point the voltage changes comparatively little with the excitation, and the E.M.F. of the alternator will vary but little with increasing load.

In order to determine the actual fall of pressure of these machines from no load to full load, the short-circuit current curve was experimentally obtained in each case. The terminal voltage of an alternator under short circuit is, of course, zero, and on account of the low resistance of the armature windings, the pressure required to drive the full load current through the short-circuited armature against its ohmic resistance is insignificant. Consequently the current circulating in the windings is practically wattless, and with a given field excitation, it attains such a value* as to produce an equivalent (and opposing) armature flux, which balances the flux of the field system produced by the exciting ampere-turns. The resultant of the impressed flux (due to the ampere-turns on the field system), and of the opposing flux (due to the reactive ampere-turns of the armature), is the actual flux existing in the armature iron corresponding to the short-circuit current, and is, of course, of small value. It may be regarded as being made up of two fluxes in quadrature, one (quite insignificant) corresponding to the small pressure required to drive the short-circuit current against the ohmic resistance of the windings; the other, a larger flux corresponding to the inductive E.M.F., and this latter flux is the true leakage flux of the armature. A little consideration will therefore show that the short-circuit current gives the relation between the ampere-turns on the field magnets and those on the armature, or what is the same thing, it expresses

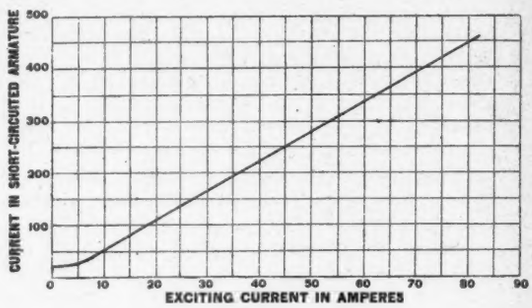


Fig. 3.

the relation between the field current and the armature current. It is, therefore, a straight line, as shown in fig. 3, which represents the actual short-circuit current curve of Alternator No. 1.

The magnetic leakage of the field system need not be separately known for a given alternator, as it is already included in the magnetisation curve, being present practically to the same extent at no load. But in order to calculate what increase of field excitation is necessary for the alternator from no load to full load, it is necessary to know the amount of the leakage flux in the armature, for, owing to the fact that the magnetic leakage in the armature increases with the current in the latter, it of course necessitates an increase of the field excitation.

For the generators in question the amount of the leakage fluxes of the armatures was experimentally found in the following manner, the leakage flux in each case being determined in terms of the E.M.F. corresponding to it. Each generator was loaded up to the extent of 100 amperes per phase upon a full inductive load, the pressure at the terminals of Alternator No. 1, under these conditions being 2,140 volts per phase, and the excitation 150 amperes. The pressure corresponding to this excitation is, (from the no load characteristic), 2,380 volts, this being the pressure per phase actually induced in the windings of the armature. As the external load is (practically) purely inductive, the excitation for the induced pressure is the sum of the excitations for the terminal pressure, and for the inductive E.M.F. of the armature. In this case, the induced pressure is 2,380, the terminal pressure 2,140, and the excitation corresponding to the inductive E.M.F. is easily found as below, giving, by simple subtraction of the excitations and pressures, the value in volts of the inductive E.M.F. representing the magnetic leakage of the armature.

(To be continued.)

* The actual value of the short-circuit current at a given excitation depends to a minor extent upon the form of the pole shoes, and on the magnetic leakage of the field system.

ELECTRIC TRACTION IN ITALY.

In the current number of the *Engineering Magazine*, Signor Enrico Bignami rubs in the usual indictment of British slowness in adopting improvements, by showing, un-

consciously, the marked contrast between the smaller towns and cities of this country in regard to electric traction development, as compared with his own country of Sunny Italy, which we are perhaps inclined to look on as a poor one-horse affair.

Not only, however, are all the leading Italian towns provided with their electric tramway lines, but a great development of *bonâ fide* electric *railway* work has latterly begun, with lines many miles in length, but with a by no means frequent service.

Amongst the principal Italian urban tramway systems we find the following:—

Florence,	one mile of tramway	per	6,000	inhabitants.
Genoa	"	"	2,600	"
Milan	"	"	5,900	"
Rome	"	"	15,000	"
Turin	"	"	8,000	"
Leghorn	"	"	14,000	"
Naples	"	"	55,000	"
Palermo	"	"	25,000	"
Catania	"	"	5,000	"
Spezia	"	"	2,000	"

Half-a-dozen others are also mentioned, but no details are given of the length of lines, so that they cannot be compared quite similarly. Of course, the above figures are by no means altogether indicative of great progress, though, on the other hand, some of them seem to show much greater mileage per unit of population than we have reached in this country.

It is, moreover, only right to remember that the three places showing least mileage—Rome, Naples and Palermo—are old cities with narrow streets that render almost impossible the working of tramways on an extensive scale.

Leghorn, too, has only just lately opened its electric tramways; but one may fairly expect to see a very great increase during the next few years in this and other cities as the conditions become more favourable.

Whilst acknowledging in many cases the great mileage superiority of Italy and of other Continental countries in regard to electric tramways, it is, however, very doubtful whether equally great superiority could be claimed for the thoroughness and solidity of the work carried out.

Board of Trade regulations, and the national tendency (much intensified by the action of local authorities) towards lavishing money on heavy construction work, do not conduce to greater margins between total expenses and receipts, and may, therefore, in many cases, prevent early development of poorly paying extensions. We must, however, console ourselves with the thought that if we haven't so much mileage as other countries, what we have got is, perhaps, of a better quality.

One of the most interesting features about the Italian tramway systems is the large number of them that are operated by means of water-power, involving the use of high pressures, and, as a rule, the generation of polyphase currents.

At Milan, for instance, the transmission is at 13,500 volts, three-phase, over 13 miles; everyone knows of the Tivoli works, which supply current for the lines at Rome—5,000 volts alternating, over 18 miles. For some of the Turin lines there is a transmission of about 20 miles, and although it is not, strictly speaking, in Italy, we may also mention in this connection the line at Lugano (5,000 volts three-phase, over 7½ miles).

Finally, there is the electric *railway* (of which a good deal has been lately heard) now being equipped between Lecco and Sondrio, with a total length of 65 miles. About 7,500 H.P. is available at a water-fall 15½ miles from Sondrio; current is to be generated at 20,000 volts, three-phase. A transformer station every 6 miles or so will serve to give the working pressure of 3,000 volts. If this line can be worked at a reasonable figure, we ought soon to see some developments in this country, where there must be scores of even shorter lengths working a "shuttle" service of a much denser nature, and where, therefore, electric traction ought to show much better results. Railway managers might do worse than combine business with pleasure by a brief trip to Italy in this connection!

THE ELECTRICAL WORKING OF MAIN LINE RAILWAYS.

By ERNEST KILBURN SCOTT.

Mr. Langdon is to be congratulated on so ably forwarding the crusade against that itinerant engine and boiler—the modern steam railway locomotive.*

With the enormous development of electric street traction and the successful working of real electric railways in America, Switzerland, and in London, the feeling has grown that it is merely a question of time when electricity will be applied to the working of main line railways. Financial data were, however, required to present a case to railway directors and shareholders, and Mr. Langdon's paper is an effort to fill this want. Coming, as it does, from one who has been connected with the Midland Railway for many years, and being data directly applicable to that part of the Midland Company's line between St. Pancras and Bedford, the particulars are all the more valuable.

A notable fact about steam railroading statistics is, that although there have been years of time in which to collect and tabulate data, yet that which is available, when compared with what electrical engineers can present in their work, is only scrappy and approximate. It is the nature of electricity to be accurate, and once let it get a grip on heavy railroad work, and we shall know to the second place of decimals just where we are. Of course, in applying electricity to existing main line railways, a number of new points come into prominence, and not the least important of these is the question of the picking up of current. The liability to floods would appear to make it impossible to collect current from a third rail laid along the sleepers, for although some lines are not troubled with floods, yet the system eventually adopted would need to be applicable to all railways. That the conductors will have to be above ground seems a necessity also, because of the impossibility of fencing off the whole of a main line railway. Then there is the question of how to carry the conductors. Are they to be trolley wires supported by span wires, or are they to be wires or rails mounted on posts at the side of the road? It is interesting to note that Siemens & Halske have recently made elaborate experiments on a three-phase locomotive picking up current with bow trolleys from three conductors at the side of the roadway. The collection was very good at 37 miles an hour, and at voltages ranging from 500 to 10,000, the sliding contacts working best at the higher pressures. It is hopeless to expect that our Board of Trade will ever allow overhead conductors to carry current at 3,000 volts, as is being done on the Colico line in North Italy, now being equipped by Ganz & Co. Yet there is much to be said for the system, as it allows of the heavie t traffic being worked from trolley wires of about the same section as is used for tramways. The method used on this line, by which the train automatically switches current on to the section immediately ahead, is a valuable feature, which may probably be eventually adopted on all railways whatever the voltage.

In looking through Mr. Langdon's figures, it appears that he has based his estimates on a system similar to the Central London, in which rotary converters are employed to deliver continuous current at 600 volts to locomotives. The Central London Railway has been a remarkable success, but, in considering what are the reasons for this, it is well to discriminate between the various factors. It would be as unreasonable to give all the credit to the very fine civil engineering work, as it would be to say the purely electrical part of the work is the sole cause of success.

Leaving out the question of the advisability or not of hauling trains by separate electric locomotives, it says much for electrical working that even Mr. Langdon's figures make out such a good case. It is certain that better figures can be given by adopting three-phase throughout.

In calculating the efficiency, Mr. Langdon allows 10 per cent. loss in the rotary converters. Again, the cost of the five sub-stations and their equipment is put down at £80,000, or 17 per cent. of the total capital outlay, whilst the wages

* Mr. W. Langdon's paper on "The Supersession of the Steam by the Electric Locomotive," read before the Institution of Electrical Engineers, November 29th, 1900.

of the five assistant engineers, &c., at the sub-stations is £5,472, or nearly 15 per cent. of the total estimated cost of generation and distribution of current. The sizes of these percentages show that any simplifying of the sub-station part of the system would make a very considerable improvement in the showing for electricity. Dispensing with rotary converters and the accessory apparatus for starting up, also the continuous current switch gear, besides having shorter cables and smaller buildings, would probably reduce the £80,000 by one half. Again, in the attendance at the sub-stations there would be a great saving, because the working of the Swiss polyphase railways has shown that step-down transformers can be very well left to look after themselves. For 50 miles of line the five assistant sub-station engineers could probably be reduced to two, and they would be more in the nature of electrical-way engineers whose duty it would be to assist the permanent-way inspectors.

In comparing the working of a main line railway in which in the one case the transformer stations are fitted with rotary converters and their necessary step-down transformers, and in the other case the sub-stations are fitted with three-phase static transformers only, it is obvious that on account of there being practically no attention required in the latter case, the sub-stations can be placed at much more frequent intervals and thus give a better service. For instance, Mr. Langdon suggests in his paper that the rotary converter sub-stations shall be at intervals of 10 miles, but on the Burgdorf-Thun Railway it was found that without incurring undue expense the static transformers can be placed at intervals of only 1·2 to 2·1 miles apart.

Again, take the question of output of the transformers in any one station. The rotary converter is a synchronous piece of mechanism, and as such the extent to which it can be suddenly overloaded is distinctly limited. Therefore, in deciding on the size of the rotary converter it is absolutely necessary that the rotary should have an output equal to the maximum that will ever be taken, and this in inclement weather would of course be very much greater than is required under average conditions. Now, it must be remembered that the trains on these main lines do not run at two-and-a-half-minute intervals, or at ten-minute intervals, as do the trains on certain London underground lines, but that there are, let us say, only 16 trains per 24 hours, as given in Mr. Langdon's paper. Assuming one train at half-hour intervals going past any particular sub-station, then the large capacity rotary converter is only taking its load for a few minutes every half hour, the rest of the time being simply spent in running round doing nothing. Now, it is well known that in any ordinary dynamo or alternator if the full load is only on for a moment or so during extended periods quite a small machine may be put in, for between periods it has time to cool down. This will not do, however, for a synchronous machine such as a rotary converter, because, as mentioned above, the question of an overload stopping the apparatus has to be reckoned with.

The condition of affairs if we equip each of the sub-stations with three-phase static transformers only, is very different, as the apparatus would, on open circuit, be wasting only a very small fraction of what is required to keep the rotaries running, to say nothing of the power and accessory apparatus required to bring them up to synchronism. Static transformers working under the conditions mentioned above, will take large temporary overloads, and therefore, in deciding on the outputs of the various units in the sub-stations, this fact can be taken into account, with the result that the three-phase equipment comes out very much cheaper.

Punctuality is not the least of the advantages which would follow from the application of three-phase traction. The *raison d'être* of the Burgdorf-Thun line is that it forms a junction to four main lines leading out of Berne, and the fact that it never fails to enable passengers to make connection is an object lesson to some of our home railways. The gradients are extremely severe—at one point being 1 in 40, and yet, whatever the load, the speed is practically constant throughout the whole of the 31 miles' run. It is about 5 per cent. below 40 kilometres an hour going up, and about the same percentage above 40 when coasting down the gradients, because, of course, in coming down the motors return current to the line.

It is significant that some existing steam railways are already seeking powers to work sections of their lines by electricity. During the Parliamentary Session of 1900 the following railways applied for such powers:—Bray and Enniskerry Railway, Wicklow; Knott End Railway, Lancashire; Mersey Railway; Metropolitan District Railway; South-Eastern and Chatham and Dover Railway; Vale of Rheidol Light Railway; and the Wirral Railway.

REVIEWS.

Les Décharges Electriques dans les Gaz. Translated from the English, with Notes by Louis Barbillion, and a Preface by Ch. Ed. Guillaume. Paris: Gauthiers-Villars. 1900.

The original English edition of "Electrical Discharges in Gases" was reviewed in these columns on its publication, and we expressed at that time our great appreciation of Prof. Thomson's fascinating work. Its translation into the language of a country in which so much work has been done during recent years in the study of radiations was to be expected. The French edition has several very valuable features of its own. We have recently printed a translation of M. Ch. Ed. Guillaume's extremely interesting Preface on the discoveries of Becquerel, Mme. Curie, and G. C. Schmidt, of the radiant properties of uranium and thorium, and of the new hypothetical elements radium, polonium, and actinium. M. Louis Barbillion, the translator, has added a number of notes on recent problems in connection with the subject. The additional matter may tempt many who already possess the English book to buy this translation as well.

Traité de Magnétisme Terrestre. Par E. Mascart, Membre de l'Institut. Paris: Gauthiers-Villars. 1900.

In his Preface to this book the author writes, "When in 1882 the Government decided, on the proposal of Admiral Cloué, Minister of Marine, that France should take part in the international Polar expeditions, the Commission formed by the Academy of Sciences to organise the Cape Horn expedition employed me to give a course of lectures to naval officers on the instruments and methods used for observing terrestrial magnetism. I have been repeatedly asked for copies of these lectures, of which but a small number were printed, and I have since had occasion to complete them in lecturing on the same subject at the Collége de France and the Ecole Supérieure de Marine."

The principal chapters are on the elementary theory of the electro-magnetic field, on the properties of magnets, on the field of the earth and magnetic charts, on observatory instruments and portable instruments for observing the magnetic elements, on the periodic variations and their relations to other phenomena, such as auroras and earth currents, and, lastly, a chapter on the errors and regulation of ships' compasses. It is an admirably comprehensive manual to put into the hands of ships' officers, and an excellent example of the French gift for writing treatises.

Injectors: Their Theory, Construction and Working. By W. W. F. Pullen. Second edition. Manchester: The Technical Publishing Company. 1900.

The injector is a curious instrument at first sight, and is looked on as somewhat of a paradox. It is useful for two purposes. One of these purposes is the feeding of boilers; the other is that of serving as an excuse for the free use of the mathematical pepper box which is much in evidence in the opening chapters of this book.

We fear that the mathematics are of little use to most men, who need to know or wish to know the principles on which the injector works. Much of the darkness on the subject exists because of the neglect in men's minds of the atmospheric pressure. They overlook the fact that ordinary exhaust steam has a pressure equal to the atmosphere, and

in this connection!

Engineers, November 29th, 1900.

that this steam will rush into a partial vacuum at a high velocity. The injector thus acts simply by virtue of the mixing of one fluid at a high velocity with another fluid at a low velocity but at a low temperature. The second fluid condenses the first and produces the effect of a vacuum, and the conjoined streams move forward with a mean momentum.

The various questions relating to injectors are well explained, and the author passes on to the historical portion of his subject and brings it down to date, explaining the many forms of injectors, also the exhaust injector which more than all others puzzled the unthinking, and is still far too little known. The various forms of restarting devices are shown, and the illustrations of the book are excellent. We ought, in fairness, to say that the mathematics are really of a simple order, but as in other books of the same author, like certain species of caterpillar, they have put on the "terrifying" aspect. As with fans, centrifugal pumps and electrical generators, one injector may be put in series with another to secure its working against higher pressures.

Motor Vehicles and Motors. By W. Worby Beaumont. Westminster: Archibald Constable & Co. 1900.

This is a huge and elaborate book, well printed and very well illustrated, but it is not exactly an engineering work. It gives very full details of mechanism, but very little on principles. A reader of the book who had searched through it—a man of some considerable experience in cars—remarked that he had only learned one thing in searching through it for information, and that was that Daimler motors compressed to 45 lbs. We look in vain for any information on the chemistry and properties of petrol. No information appears on the indicator diagram of the petrol motor—not a single diagram is even illustrated as an aid to the maker of a new petrol motor which shall tell him if he has improved on past records, and generally there is a great paucity of information outside mere mechanics and construction. There is some practice, too, but we look in vain for any hint to the unfortunate user of a car that he should not look for new belts, but should stipulate that his vehicle be supplied with an old supple belt just removed from a lathe or other machine, well stretched by some months of work and thoroughly softened. Usually the belts are new, they slip and squeal and are most troublesome and unsatisfactory.

The motor car industry has been one of the most fraudulently conducted of businesses. In its recent rise from obscurity, it went down from Jerusalem to Jericho, and has never fairly recovered tone. There is much that is to be deplored in the present conduct of business, and there are large numbers of cars sold of most deplorable construction. Many come from Germany, and are clearly made to sell, but not to give satisfaction. We hear of cars sent home to purchasers that cannot be started again after the seller's expert has left them.

Much trouble appears to arise with the carburators, and, indeed, the vagaries of a car are innumerable. There is little in this book to help us to arrive at any idea of the true power of the petrol motor. The author appears satisfied to use the words "stated horse-power," or "claimed horse-power." Is the stated horse-power to be added to our old nominal steed? What with the nominal, the indicated, the brake and the electrical horse, we might have been spared this new colt, the "stated horse"-power, or the "declared" horse-power, on which we find some very curious figures based in Table XVI. Thus, if a man buys a certain motor car and it does not come up to his expectation, he may be told that it is based on the mean of about a score of other makers' cars. We find nothing said upon brake horse-power. Yet some recent experiments seem to show that the brake horse-power of a petrol motor is very far below the declared horse-power, and that while a horse may do several horse-power without "a bustin of hisself," the declared power of a car is much above the actual, which may account for so much uphill creeping.

There is far more engineering information afforded upon steam than upon petrol vehicles. Here we find figures of cylinder sizes, grate and heating surface, and so on, items only paralleled, so far as we can see, in one table as regards petrol cars. This is a pity, because the petrol car has a future, and is too little understood. The industry, it is true, is spreading, but it is doing so in a false atmosphere, and in the hysterical surroundings of races and promotions, ill calculated to give happy results.

The book before us consists therefore chiefly of the contents of catalogues, with excellent added drawings, without dimensions, however, or scale. Under the heading of "The Best Vehicle," we are told there is none, which reminds us of the consular report on certain islanders' manners and customs. Credit is given historically to Hancock and to Gurney, who did much in steam carriages 70 years ago or more. The after history of road vehicles is well illustrated, and seems to show that the men of that time were as good, or better, engineers than those of to-day.

Research is made in Chapter III. into the question of power and frictional losses and lubrication. Reference is made to the effect of ball and roller bearings, and they are much praised. We cannot accept that roller bearings reduce the starting effort to 24 per cent. of that with ordinary bearings. It is all a question of starting velocity—of acceleration, and the entire abolition of friction cannot abolish the natural laws connected with mass acceleration, which has nothing whatever to do with friction.

Road resistance is dealt with in Chapter IV., while gravity effects are dealt with in Chapter V., air and wind resistance in Chapter VI.

In Chapter VII. we find an account of the modern petrol vehicle, beginning with Daimler, and describing this and many other cars and their various details with considerable fulness. Ignition apparatus has a chapter to itself.

There is much of interest in the book, which represents an immense labour of compilation, if not much original study. The would-be inventor may learn something of past attempts, and the would-be purchaser or user can find out something of the anatomy of his car. We could wish it were as easy to give rules for the discovery of the many painted oft sold vehicle of the type that we believe is often palmed off on the unwary.

NATIONAL PHYSICAL LABORATORY.

The following report on the work of the National Physical Laboratory was presented to the Royal Society at their meeting on November 30th:—

Statement as to Work to be Undertaken in the Year, October 1st, 1900, to September 30th, 1901.

Under this head it may be useful to give a brief summary of the investigations which, in the opinion of the Sub-committees appointed to draw up suggestions as to work, might be usefully undertaken. At the same time it must be pointed out that until the new buildings are available, few, if any, of these investigations can be carried out. For the present it seems best to develop the work which has been carried on at Kew for some time past, rather than begin new experimental work.

Thus the testing work will go on, and in some respects be extended. The Committee have received communications from the Board of Agriculture with regard to the testing of certain apparatus used in the dairy industry, while the director has been in communication with various firms as to the testing of burettes, flasks, &c. It is hoped that it may be possible at once to take up this work.

The Laboratory has now conveniences for platinum thermometry; as one result of the director's visit to Berlin, it appeared desirable to have a comparison between the high temperature scale in use here and that employed at the Reichs-Anstalt. Thanks to the courtesy of President Kohlrausch and the officials of the Reichs-Anstalt, arrangements for this are now in progress. The work with the gas thermometer will continue, and the Committee hope, during the year, to have Sir A. Noble's instrument in order as a standard of temperature.

The fact that the B.A. standards have been placed in the Laboratory renders possible some necessary work on electrical units, in particular the construction of mercury resistance standards. Preliminary steps have been taken with this object.

Sub-committees were appointed, as has been mentioned already, for the purpose of drawing up a series of suggestions as to the work which might most usefully be carried out in connection with the following branches of science or industry:—Mechanics and engineering, electricity, optics, chemistry, meteorology, terrestrial magnetism, thermometry, legal standards, and the following is an analysis of their principal recommendations:—

the same percentage above 40 when coasting down the gradients, because, of course, in coming down the motors return current to the line.

subject exists because of the neglect in men's minds of the atmospheric pressure. They overlook the fact that ordinary exhaust steam has a pressure equal to the atmosphere, and

Three Sub-committees—viz., those for mechanics, chemistry, and electricity—mentioned practically the same investigation as that to which attention ought in the first instance to be devoted. The terms of the recommendation of the Electrical Sub-committee are as follows:—

"The connection between the magnetic quality and the physical, chemical, and electrical properties of iron and its alloys, with a view specially to the determination of the conditions for low hysteresis and non-ageing properties."

The other recommendations refer specially to the work of Sir W. Roberts-Austen and the Research Committee of the Institute of Mechanical Engineers. It would seem therefore to be desirable to provide for this work.

Another important task suggested by the Mechanics Committee, which ought, moreover, to prove remunerative, is the testing of various gauges and dynamometers, indicator springs, and the like, and also of gauges of various kinds used in engineering practice. The necessity of further investigation into the methods of measuring wind pressure was also urged.

The Electrical Sub-committee give the second place to the testing and calibration of electrical and magnetic instruments, as also of samples of iron used for transformers and other magnetic purposes. This work again ought to be remunerative.

The Chemistry Sub-committee suggest investigations into the conductivity for heat and coefficient of transmission of radiation of various substances in general, and also as bearing on the question of gaseous fuel.

The Sub-committee on Thermometry describes the present thermometric work of the laboratory, and expresses the opinion that it ought to be developed—

1. By extending the range of temperature over which thermometers are tested.

2. By providing for (*a*) gas thermometry, (*b*) electric thermometry.

3. By arranging for a more exact study of the mercury in glass thermometers.

The Sub-committee on Electricity again calls attention to the necessity of investigation into certain electrical measurements, and Mr. A. P. Trotter, at the request of the Committee on Legal Standards, has submitted a valuable list of measurements, by means of which the work of the Electrical Laboratory of the Board of Trade would be supplemented and assisted.

The Sub-committee on Optics recommend that the work of testing telescopes, binoculars, photographic lenses and sextants should be extended, and that microscopes and certain other instruments should also be tested.

At the request of the Sub-committee on Legal Standards, Mr. Chaney has furnished a statement as to instruments verified by the Standards Department of the Board of Trade, with suggestions as to investigations in which the laboratory might assist the department.

The Sub-committee on Terrestrial Magnetism, in view of the doubt as to whether Kew can be sufficiently protected against magnetic disturbances due to tramways, do not recommend any immediate and expensive changes in this department, but they point out that, if Kew is to continue to rank with stations such as Potsdam and Pawlowsk, the extension of the Observatory will be necessary in the not very distant future, and that this will involve a considerable outlay.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be as brief and concise as possible. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

No. XXXIV.

Seth Thomas writes:—"A large landowner whose estate covers several thousand acres proposes to erect an electric supply station on his property for the sole purpose of supplying his numerous tenants with current for lighting and power purposes.

"1. Is he legally entitled to charge his tenants for the supply without an undertaker's license?

"2. Is he entitled to carry his mains across the public thoroughfares dividing his estates?"

*** There is certainly nothing in the Electric Lighting Acts to prevent a landowner erecting an installation and making use of the same in the manner suggested by our correspondent. With regard to question (1), it is clear that it was before 1882, and still is open to any of the Queen's subjects to generate and supply electricity in his own premises and use it himself, or, for the matter of that, supply it to other persons and places, and make a charge therefor, provided that no injury to the property, convenience or comfort of any other person or authority, or the public be thereby inflicted.

With regard to question (2), it is necessary to draw a distinction between mains "carried across" and mains "laid under" a public thoroughfare. Our correspondent is obviously cognisant of the importance of this distinction. Parliamentary powers are necessary for the breaking up of public streets or interference with any other public rights. Since 1888, however, persons unauthorised by statute or statutory concession, as well as undertakers erecting (*inter alia*) overhead electric lines otherwise than in pursuance of the Acts or any license, order, or special Act, may be made amenable at any time on notice to the regulations and requirements of the Board of Trade and the Postmaster-General in the interests of public safety and telegraphic and signalling communication, under heavy penalties and further liability to summary removal of the electric lines. Subject, however, to the risk of being, so to speak, pounced upon by the Board of Trade, it would seem that any person may place electric lines across a highway, provided they exceed a certain height.

PIECEWORK.

Piecework has given rise to more trouble than any other factor in the relations of employers and employed in the manufacture of machinery or any other article. There is one noticeable exception that occurs to our mind, and that is in the textile trades. All the way through a cotton factory piecework prevails in almost every department, and it is a curious fact—perhaps only a coincidence—that the better class of labour in the cotton factory is paid by the piece, and the departments where piecework does not prevail are the worst paid. But in textile machinery every machine of the same class is identical with all the rest. It runs at the same speed, and is driven by an engine which turns steadily at a speed practically invariable. It is thus easy to calculate exactly how much a machine will produce in a given time, and all that it falls short of this production simply represents the skill of the operator. That operator who can most rapidly piece up broken ends will most nearly approximate to the 100 per cent. of output that would be given if no ends broke down, and it was therefore not necessary to stop the machine to piece up. Other machines never stop, ends are pieced up while running, and the output is purely a question of skill and quickness of the operator. There is a definite fixed maximum wage, beyond which the best operative cannot go, unless the engine be speeded up. There are no disputes except as to the rate per 100 lbs., and there can be no possible question of dodging on the part of either side. In some cases the operative is paid simply by the number of revolutions made during the week by a certain roller in the machine. This avoids weighing the output, and implies the repose of a considerable trust in the operative, who is expected to stop the machine to piece up, and thus loses a little every time he does so.

In engineering work such strictly accurate rating for piecework is not possible, and has been left unattempted by the majority. In an article by Mr. C. W. Hill in *Feilden's Magazine*, an attempt was recently made to calculate the time of an operation, so as to enable piecework to be better estimated. It is certain that the very crude attempts at rating work have been at the bottom of all piecework trouble. A rate is fixed, and a workman begins to make a huge wage. As a rule the rate was, perhaps, one he originally objected to as insufficient, but it was forced on him by the management, and he accepted it under protest. As soon, however, as the management find that the rate is too high, they begin to grudge the man his share in the speculation into which the man did not wish to go, and, as a result, a heavy cut in rates is made. Now, it is the duty of every management to be able to fix a rate on which a workman shall, by reasonably hard work, be able to earn more than by day rates. To enable this to be done, Mr. Hill says that each machine tool must have a feed and speed table prepared for it, and that notes should be continuously taken of the time necessary on all the elementary hand operations, such as changing a wheel, taking off a face plate, and so on. This, and the time of each operation on a piece, can thus be made out for any price. The hiatus is the time occupied in getting stuff out of stores, and so on. It seems to us that if machine work is to be done by the piece, the management should see to it that the whole of the materials are delivered free at the machine. To determine cost, it is necessary to know what cutting speeds can be run on each piece of work, the strength of the machine, and of the piece itself, and the accuracy limit required. All these factors come into the calculation of a piece rate. Our author gives tables and formula for certain calculations on the lathe, planer and miller, and so on, with a view to explain the calculation of prices.

The article is interesting and instructive. We need hardly say that piecework can only be worked in a shop with a proper provision of tools, and with a proper tool room and stores organisation.

THE DONKIN REVEALER.

If an esteemed electrical contemporary is right in what it says during the course of a criticism of the Donkin revealer, this instrument has been very much over-praised. The idea embodied in the instrument is that the behaviour of steam in an engine cylinder may be concluded from the appearances to be observed in a small glass vessel, which is fixed upon a pipe that communicates with the interior of the cylinder in a manner similar to an ordinary indicator. Our contemporary altogether doubts this comparison, and avers its belief that the appearance of the steam in the revealer is no evidence whatever that the same behaviour is going on in the cylinder itself. We think the criticism is well founded. We entirely fail to see how it is possible that a small vessel, apart from the cylinder, to reveal the action within the cylinder itself. We go further. We do not believe that the behaviour of one portion of the interior of a cylinder is even as that of another part of the same cylinder. Each part of a

cylinder sizes, grate and heating surface, and so on, items only paralleled, so far as we can see, in one table as regards

heering, electricity, optics, chemistry, meteorology, terrestrial magnetism, thermometry, legal standards, and the following is an analysis of their principal recommendations:—

cylinder is perfectly free to act upon the steam, and be acted upon by the steam in its own way.

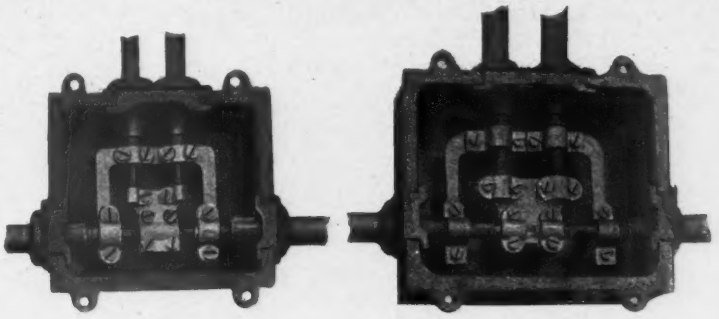
There are no grounds for assuming that the interior skin of a steam cylinder ever attains the temperature of the initial steam, or ever becomes so cool as the exhaust. There are more or less close approximations to both these limits, but it is all a question of speeds, position of the particular area, and probably also of the thickness of metal behind that area. The condensation and re-evaporation due to each square inch of area can go on to some extent independently of the remainder of the exposed areas, and a full view of any particular area within the cylinder itself could not be held to be at all representative of the whole. At the same time it is possible that the method of illuminating the interior of a cylinder, suggested by our contemporary, would be a much better plan than the use of the small external revealer, whose action is quite separated from the cylinder. The phenomenon of cylinder condensation is one that can be reasoned upon without experiment. No one doubts that the interior surface of a cylinder tends to attain to steam temperature, and is therefore always absorbing or giving out heat. The effect of cylinder condensation is well known, and the hidden mystery that some writers try to attach to the vagaries of the steam jacket is mostly explicable on the grounds of speed, or of inefficiency, and air trapping or other abnormal cause. The recognised and accepted behaviour of steam in a cylinder is strongly supported by the remarkable increase of efficiency that arises from a small amount of heat introduced as superheat. The effect of superheat is out of all ratio with its amount, but is perfectly clear if we accept the recognised reading of cylinder condensation effects.

That something may be learned from the revealer we will not dispute, but its revelations are to be treated with great caution, and must not be relied on as any proof of similar simultaneous action in the working cylinder.

ELECTRIC LIGHT JOINT BOXES.

A few weeks ago Mr. Andrews described in our columns the method of joint making employed at Hastings, and in a subsequent issue Mr. E. Hammond made reference to his system which had been adopted at Edinburgh. We are now able to give drawings of boxes and fittings on Mr. Hammond's method, with views of boxes Nos. 1 and 2 fitted with cables complete.

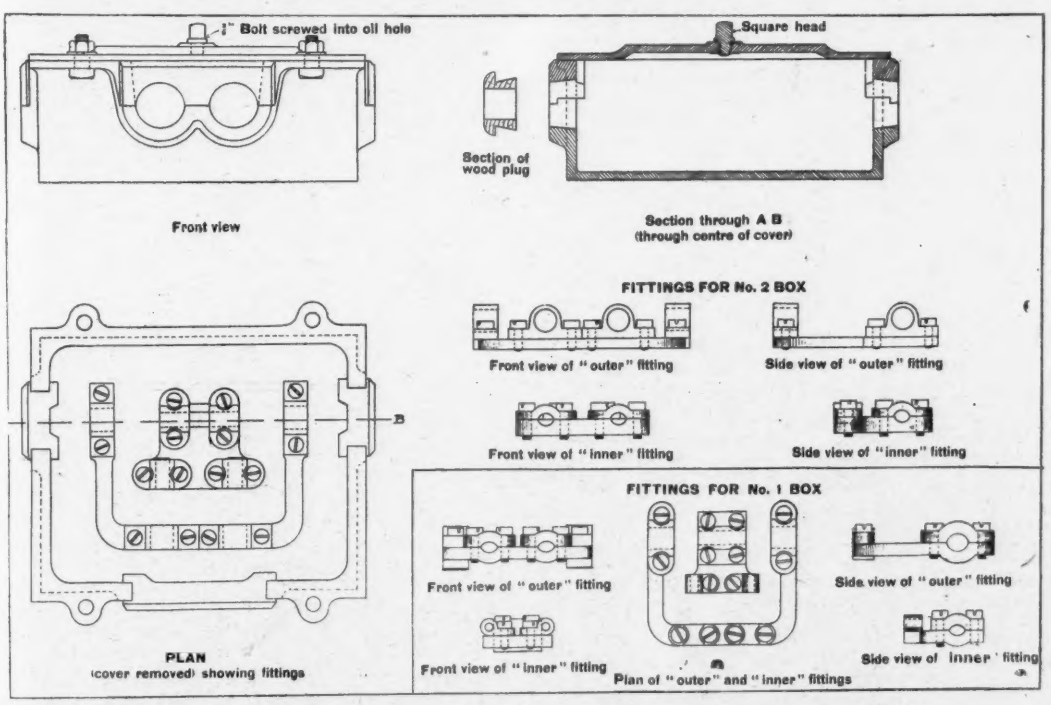
The boxes in use at the present time consist of the following parts:—No. 1. A square iron casting, 3½ × 8½ × 7½, with four slotted ways for cables entering. The slot is made so as to form a half circle. The circle is completed by a small sliding casting, and on the service side by a casting forming two half circles. The slot is tapered inwardly; the cable passes through a beech bush which is tapered to fit the slot, so that when the slide is in position it is completely locked. The "outer" fitting consists of a bar of tinned gun-metal, forming three-quarters of a square and fitted with clamps for the outer of each cable. The "inner" fitting is a dovetail-shaped plate of gun-metal cast with a groove for the main core and fitted with a square clamp on top with four screws, and two small thimbles for sweating on the inner of the service cable. In putting in this box there is no need to cut the inner core through, as the bushes can be put on in two parts. It is capable of taking a



No. 1. No. 2.

19/16 or 19/14 main and two 7/14 or 7/16 or 19/18 services, or can be used as a straight 19/14 with the same fittings, but substituting two dummy bushes on the service side.

The No. 2 boxes are similar to No. 1 but larger, and the fittings are made so that each way can be disconnected separately. The outer fitting is made of a tinned gun-metal bar forming three-quarters of a square. The outer connection is made by sweating a ferrule with two wings on to the outer of the cables, which is then clamped to the bar by two ¼-inch screws. The inner consists of a dovetail-shaped gun-metal plate cast with four grooves to receive four cables and fitted with a clamp for each separate core. To disconnect a cable when alive, after applying the blow lamp to the lid, this will soon lift off, then the small slide is warmed, which will lift out, then the wax is scooped back with a piece of wood until the two fittings that it is desired to disconnect are exposed. The clamps are then released and the cable lifted up. There is no need to switch off to bring in an extra cable to an existing box; if the jointer is careful he need only expose the two clamps that he requires to connect. In putting on new boxes, one great benefit of the Hammond system is that all fittings can be connected to the cable, before being placed in position. The boxes are filled up solid with bitumen wax.


½" Bolt screwed into oil hole
Front view
Section of wood plug
Square head
Section through A B (through centre of cover)
FITTINGS FOR No. 2 BOX
Front view of "outer" fitting
Side view of "outer" fitting
Front view of "inner" fitting
Side view of "inner" fitting
FITTINGS FOR No. 1 BOX
Front view of "outer" fitting
Side view of "outer" fitting
Front view of "inner" fitting
Side view of "inner" fitting
Plan of "outer" and "inner" fittings
PLAN (cover removed) showing fittings
B

Details of Cast-Iron Service Box, Size No. 2, and Fittings for Nos. 1 and 2.

Electrically-Operated Bridge.—The *Steamship* states that a syndicate has been formed for the purpose of erecting an aerial bridge across the Tyne between North and South Shields; a Bill will be promoted in Parliament next session with a view to seeking the necessary powers. The proposed bridge is to be 200 ft. high, with a clear span of 640 ft.; it will be erected on the principle of a platform suspended by cables, and will be worked by electricity supplied by the Corporations of Tynemouth and South Shields.

E

DINNER OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The twelfth annual dinner of the Institution took place at the Hotel Cecil on Monday evening, Prof. John Perry, F.R.S., the president, taking the chair. About 350 were present. Among the company were Mrs. Ayrton (the only lady member), Lord Kelvin, Lord Alverstone, Lord Morris, Sir W. MacCormac, Sir Courtenay Boyle, Sir J. Kitson, Sir E. Carbutt, General Sir R. Harrison, Lieut.-Colonel R. E. Crompton, Sir Andrew Noble, Sir John W. Barry, Sir W. de W. Abney, Sir Henry Roscoe, Sir Philip Magnus, Sir Archibald Geikie, Sir J. N. Lockyer, Sir W. Roberts-Austen, Sir Henry Mance, Prof. W. E. Ayrton, Mr. A. Siemens, Bailie A. D. Mackenzie, Mr. J. W. Swan, the Rev. C. Stower, Mr. W. J. Hammer, Prof. Short, Mr. F. H. Webb, Councillor J. T. Skinner, Mr. S. W. Higginbottom, M.P., and many other distinguished gentlemen.

The President having proposed the loyal toasts, Mr. S. Z. de Ferranti eulogised the splendid deeds of the Army in South Africa, and pointed out the importance of the *rôle* played by engineers in modern warfare, including the electrical engineers, of whom Lieut.-Colonel Crompton is chief. The E.Es. are due to arrive to-day by the *Norham Castle*. Admiral Holland replied for the Navy and General Harrison for the Army; Lieut.-Colonel Crompton declared it was the proudest moment of his life, and could not find words of too high praise for his gallant corps. The experiment had been a great success; finer soldiers and finer men than the E.Es. never walked, and the duties they were called upon to do ranged over the whole gamut of mechanical enginering. Out of the whole corps only four were lost, not, however, because they were not exposed to danger.

Lord Alverstone recapitulated the electrical and other scientific marvels of the 19th century, now drawing to a close (Sir C. Boyle—"No, no"), and proposed the toast of "Science and Engineering."

In reply, Lord Kelvin took for his text the recent Presidential address, which, he said, had set the whole world thinking. Archimedes was aptly eulogised as the first scientific engineer, and he, like Lieut.-Colonel Crompton, devoted his skill to the confounding of his country's foes. Electrical engineering, said Lord Kelvin, unlike any other industry, is the child of the latter half of the nineteenth century, and owes everything to mathematicians.

Sir J. W. Barry wondered why science and engineering should be spoken of as two separate things, until with the aid of a dictionary he found that the latter was an *art!* The future of engineering is largely electrical, and "*electrical engineering is still in its infancy.*" The worm will turn some day, and the man who utters that hideous commonplace will be remorselessly exterminated.

Sir James Kitson and Sir Courtenay Boyle jointly proposed "The Institution of Electrical Engineers." Sir James pointed out that it was well for us that our rivals were progressing, for they became our better customers—as proved by the returns for the last 10 years. Sir Courtenay Boyle prophesied a great future for electricity, including the accomplishment of aerial navigation. In reply, Prof. Perry plumed himself upon presiding during a session which extends from century to century, and paid a graceful compliment to the secretary, Mr. McMillan.

Mr. Swinburne proposed "Our Guests" in a humorous speech, to which Lord Morris replied in an equally amusing vein, and with a delightful touch of the brogue. Prof. Rucker and Bailie A. D. Mackenzie also replied, after which the proceedings, which at no time were very lively, came to an end.

ECONOMIES IN MACHINE SHOP WORK.

Mr. Oberlin Smith recently wrote in *Cassier's Magazine* on manufacturing machinery. A manufactured machine is one that is built up by simply putting together its several parts just as they come from the workman's hands, or rather from the machine tool. No hand fitting is to be supposed necessary, but in practice certain working parts do require some hand finish in the way of scraping. In manufacturing such a machine it is first perfected as regards its working, its performance of the duties for which it is designed. In the process of perfecting a machine for manufacture it is necessary to remodel many of its parts, it is always desirable to have each piece to measure some exact fraction of an inch or foot. Many parts, such as pins, small spindles, or bolts, will vary from their best size as looked at purely from an engineer's point of view, but this will be done to reduce the number of parts in a machine. If such a perfected machine be then taken and certain automatic machine tools are taken and so set and geared as to produce duplicates of such parts, then will any random selection of the whole series of such duplicates go together so accurately that a machine so made should at once run and perform its allotted duty. This stage is not reached at once. The first production will probably have some ill-fitting part and demand some adjustment of the jigs or templates used in the manufacture, but once all sizes have been definitely fixed up, any number of thousands of machines may be turned out in detail at the maximum of speed, and all should fit and run forthwith. Any initial stiffness would be eliminated by a few minutes' run at speed. Such is the mode of manufacture of watches, sewing machines, lawn mowers, and Willans engines.

Besides the jigs there are test gauges required, and a set of master gauges wherewith to compare the test gauges from time to time, such master gauges not to be used except with more than ordinary care. The art of correct manufacture is, in a sense, contained in the proper application of the system of limit gauges. A turned spindle, for example, supposed to be 1½ inches diameter, will be turned so that it must enter a certain one of two drilled holes in a piece of hardened steel, and it must not enter the other hole. The two holes differ perhaps by ·0008 of an inch, and all pieces that pass the test are deemed correct. Similarly, the wheels that run on such a spindle are bored to receive or reject a pair of limit gauges so selected that any wheel and any spindle selected at random from a bin containing perhaps 100 of each, will work together correctly. In carrying out such work the manager must know first that the machine he is to make will do its work. Then he must see that it is as simple as possible. It is next necessary that each of its separate parts should be of simple form, offering no obstacle to cheap manufacture, and finally the parts must be so made and their limit gauges so well selected, that while the widest ranges when opposed shall be such a fit as to come within the limits of good work, so also shall the other extreme. No finished machine should show either wobble or tightness. If such faults do occur it is evidence of a bad choice of limit sizes. Manufacturing shops that build many machines, and few of each kind, cannot go to the full extent in systematic manufacture.

Each case must be dealt with on its own merits. One cannot generalise on such things, obviously cheapness is best secured by the manufacture of articles in large numbers per batch. So much time is necessary to set many jigs that it will not pay to make less than, say, 10 at once. Turret lathes are cited as machines that require extreme accuracy of adjustment in order to produce proper work, and for small articles especially the number made to each setting must necessarily be great. Equally important is the question of feeds and speeds. The most conscientious workmen tried to run feeds and speeds too low, and these are such important factors in cheap manufacture as to demand special attention from the management so as to obtain that feed and cut that will give the maximum of material removed per unit of time consistently, of course, with the preservation of cutting edges. As we have above pointed out, American method is largely one of materials, and this factor has controlled all American practice, and has practically fixed the dimensions of American machine tools, and the relative strength and dependence of their several parts. It has been productive of a good deal of heart-burning on the part of the makers who ascribe to stupidity, what is due to harshness of material, and who fail to realise that a tool that will do well enough in America may quite fail elsewhere.

CORRESPONDENCE.

"What's in a Name?"

Under the above headline you make allusion in your current issue to the appellations bestowed upon two novel instruments which were described in the October 12th number.

Now, whilst both these "*distant* sound recorders" are combinations of the "telephone," with specific and different forms of a "phonograph," or "*local* sound inscriber," I venture to suggest that "*telegraphone*" cannot fairly be claimed as the cognomen of either, as it correctly describes an electrical apparatus of far earlier date, viz., that commonly and verbosely known as the "*telegraph sounding receiver*," or "*telegraph sounder*," to which I applied the title in question as early as 1891.

The difficulty of endowing new scientific evolutions or combinations with suitable, differentiating, and descriptive

designations is often experienced, as witness the multitude of "phonographs," "gramophones," "graphophones," &c., in this near connection, and the innumerable variations of the "cinematograph" in both its optical projection lantern and peep-show applications. Inanimate "christenings" should be on logical and etymological bases, and *generic titles* firstly applied to all apparatus of one class, as is done to all the animal species of one family in zoology, for instance; and then *fine discriminations* as to principle of working, law involved, application, and other peculiar distinctions of each member of the group employed as an adjective or adjectival clause, or even in apposition, to qualify the said generic noun, *i.e.*, cognomen, or surname. Thus, in present instance, I consider that the combination of a phonograph with a receiving telephone instrument constitutes a "*Telephonograph*," as the *generic* styling of *both* Messrs. E. O. Kumberg and Valdemar Poulsen's inventions; but *not* "Telegraphone," which immediately associates the idea of combination of a "*telegraphic*" rather than "*telephonic*" instrument with some other. The true "radix" must be preserved in all inflections.

Then to distinguish the manner in which one type performs its functions from the other, I recommend that "*Stylo*" or "Diaphragm" be used as a prefix to the group classification in the case of Mr. Kumberg's variety; and "*Inductive*" "Magnetic," "Electro-Magnetic," or other better descriptive adjective when Mr. Poulsen's apparatus is intended.

I have thought the general matter of *correctly naming new inventions*—and preferably with truly and essentially descriptive titles in contradistinction to fancy ones—of sufficient importance to bring forward, in view of the hosts of recently-devised contrivances and of those to be yet born, whose "number is legion," so as to avoid the ultimate confusion which would otherwise ensue.

Elbe.

Maida Vale, W., *December* 3*rd*, 1900.

The Electric Motor-Car Problem.

Your interesting article on the above subject in yesterday's issue suggests the following question:—Why should not an electric car be balanced on large *central* driving wheels, with supporting pairs of wheels at each end of somewhat smaller diameter? these would be for steering only, and would be connected so as to turn in opposite directions. It seems to be tacitly assumed that we are limited to two axles, but there is no mechanical reason why a third should not be added in consideration of the absence of horses. In this way a long car may be made quite as handy as a short one.

Alfred J. Allen.

London Institution, E.C.,
December 1*st*, 1900.

Electric Railway Standardisation.

The increasing price of coal and labour and the growing stress of foreign competition must inevitably bring the question of the electrification of our railways within our immediate consideration.

Within a few days a joint committee of the District and Metropolitan Railways, assisted by two eminent engineers, will meet to consider the tenders and schemes they have invited for the electrification of the Inner Circle. The importance of this undertaking has no relation to the miles of track that have to be equipped or to the power that will be required. It lies in the fact that this pioneer electrification of a steam line will influence the course of heavy electric traction for good or for evil for a number of years, and will create a vested interest in certain standards which may or may not be found to be the best. The working pressure of the current and the system of distribution and collection have the same importance as regards interchangeability of traffic as the standardisation of the gauge.

It will not be a creditable state of affairs if there is to be a repetition of the inconvenience that attended the absence of a standard gauge in the early days of steam railways.

Although we cannot yet foresee which system will eventually hold the field, it is tolerably certain that continuous currents will maintain their present predominance for a number of years.

It would, therefore, seem not too early to consider and, if possible, to give an answer to the following questions, regarded as general and not as affecting one single case:—

What shall be the standard voltage of supply for electric railways?

How shall the current be transmitted to the trains?

Shall the system be an entirely insulated one or not?

If every railway company is to solve the above problems by the process of trial and development, it is probable that there will be as many systems as there are companies. On the other hand, if companies wishing in the future to electrically equip their lines have to conform to an imposed standard set by their neighbours, it is clear that their interests are deeply involved in the system that any one company may now adopt.

A first step in the right direction will be taken by lifting railway electric traction away from the influence, methods and limitations of electric tramways. If these limitations, and especially the 500-volt standard, are not repudiated at the very beginning, the result cannot fail to be disastrous to the rapid development of railway electric traction.

Edw. H. Tyler.

Streatham Hill, *December* 3*rd*, 1900.

The Molecular Constitution of Water.

I would like to draw the attention of all your readers interested in the physics of water to an important investigation by William Sutherland, "communicated" in the *Philosophical Magazine* for November last. He thinks that sufficient data are in existence to enable one to work out quantitatively the actual constitution of water, and shows that steam being H_2O, ice is pure $(H_2O)_3$, and water a mixture of $(H_2O)_3$ and $(H_2O)_2$ in proportions whose dependence on temperature can be expressed by a simple formula.

As H_2O is very generally used as a symbol for water, and as hydrogen oxide is a long name for so important a chemical species as H_2O, he proposes, for international convenience, to call H_2O *hydrol*, $(H_2O)_2$ *dihydrol*, and $(H_2O)_3$ *trihydrol*.

Steam is hydrol,
Ice is dihydrol,
and Water a mixture of *di*- and *tri*hydrol.

The investigation includes the following considerations:—Constitution of water from its thermal expansion; confirmation from its optical refraction; compressibility of water and dissociation of trihydrol into dihydrol by pressure; surface-tension and constitution of water in surface-film; latent heat of fusion, specific heat, and latent heat of evaporation; the viscosity of water; dielectric capacity; the melting of ice as a phenomenon of dissociation, and the higher valency of oxygen; and summary of results.

He says, in his summary of results, that probably at its critical temperature water is practically pure dihydrol; that the latent heat of fusion of ice is not an ordinary physical latent heat of fusion, but is mostly a latent heat of dissociation of trihydrol into dihydrol, partly masked by heat of solution of trihydrol in dihydrol. The latent heat of evaporation of water includes also the heat of dissociation of the dihydrol and trihydrol of water into the hydrol of steam; that the specific heat of water is not an ordinary specific heat but includes a certain amount of heat of dissociation; and that pressure dissociates trihydrol, at rates given in a table.

The paper extends to some 30 pages of matter, every bit of which is worthy of the most careful consideration and study.

What applies to hydrogen oxides may in some measure apply to metallic and other oxides. The change of state, the change of molecular or interatomic surface, produced by aggregation and disaggregation of matter is suggestive of how energy is stored up and liberated, *e.g.*, in the case of heated refractory oxides and all kinds of phenomena.

J. C. R.

London, *December* 4*h* 1900.

Nalder Bros. & Co., Limited (in Liquidation).

Notice has recently been published of a report of the liquidator of Nalder Bros. & Co., Limited, who are winding up voluntarily. As some misapprehension may possibly arise owing to the somewhat similar name, we wish to point out that this in no way affects our business, which was purchased some four years ago from Nalder Bros. & Co., Nalder Bros. & Co., Limited, being of later formation. We shall be greatly obliged if you will kindly publish this.

Nalder Bros. & Thompson, Limited.
(F. H. Nalder.)

LEGAL.

Corporation of Wolverhampton *v.* the British Electric Traction Company.

Mr. Justice Joyce, in the Chancery Division of the High Court of Justice on Thursday last week, delivered his reserved judgment in this case, which had reference to running powers over the Wolverhampton Tramways. The short facts were these:—The Corporation brought their action for specific performance of a statutory contract by which the defendants or their predecessors in title were under liability to sell a tramway to the plaintiff Corporation. The question in issue resolved itself into the construction of Acts of Parliament. By an Order passed in 1880 called the Dudley, Sedgley, and Wolverhampton Tramways Order, powers were given to certain persons to construct and maintain tramways in the parishes of Sedgley and Wolverhampton. Those powers were amended and extended by the Sedgley and Wolverhampton Tramways Act of 1893, and became vested in a company called the Dudley and Wolverhampton Tramways Company, Limited. In 1899 that company disposed of its undertaking to the defendant company, and the latter took the position of the original promoters under the Act of 1880. By an Act of 1899 the Corporation obtained power to give notice to the promoters of the tramway undertaking to sell the undertaking to them for a sum to be agreed upon, and on September 20th of that year the Corporation exercised the power, but as the consideration could not be agreed upon, Sir F. Bramwell was appointed arbitrator. However, before the arbitrator sat, the purchase price of £4,250 was agreed upon, and that sum was accordingly made the arbitrator's award. The Corporation's cheque was sent for this amount, but returned, the defendants refusing to complete the contract unless the Corporation gave them running powers over the Corporation lines. The pleaded defence was that by Section 17 of the Act of 1880, it was provided that if at any time tramways were made or purchased within the borough of Wolverhampton by the Corporation, the promoters of the company should make and maintain the necessary junctions, and that the parties should grant to each other running powers over the respective lines under Board of Trade conditions. The defendants' case was that by the sale of the line in question to the Corporation, the defendants became entitled to the rights and privileges of the original promoters under the Order of 1880, but these rights the Corporation refused to give, and defendants thereupon declined to complete the sale, being apprehensive that the Corporation could sever the portion sold from the remainder of the undertaking. They accordingly counterclaimed for a declaration that, on conveyance of the tramway in question to the Corporation, they became entitled to running powers over the whole of the Corporation's system. The case was argued on the 16th ult., at the conclusion of which his Lordship said he would consider his judgment.

His Lordship, in the course of his judgment, said that the action was brought by the Corporation of Wolverhampton against the British Electric Traction Company for specific performance of a Parliamentary contract contained in the Act of 1899 authorising the Corporation to purchase within the borough certain tramways to which the defendant company had since succeeded. There was no real defence to the action, but there was a counterclaim by the defendants for a declaration that they had running powers over the tramways, and it was agreed by counsel before his Lordship that the only question in the case was whether the claim to such running powers could be maintained or not. His Lordship went exhaustively through the material sections of the Dudley, Sedgley and Wolverhampton Tramways Order of 1880, the Sedgley and Wolverhampton Tramways Act of 1893, and the Act of 1899, by which the Corporation obtained power to acquire the tramways from the defendants. He did not think that Section 17 of the Act of 1880 bore the construction attempted to be put upon it by the defendants, and their counterclaim was not well founded, and must be dismissed. There would accordingly be judgment for the plaintiffs on the claim with costs. His Lordship asked Mr. Hughes, Q.C. (with him Mr. Warmington, Q.C., and Mr. Underhill), for the plaintiffs, if he would take a declaration?

Mr. Hughes: I think the "counterclaim dismissed with costs" will meet it.

Mr. Freeman, Q.C. (for the defendants), said as there was no hostility between the parties, he thought the plaintiffs ought to undertake not to pull up the rails at the junctions until his clients had considered the question of whether they would appeal or not.

His Lordship thought that was reasonable, and asked the learned counsel how long he would take to consider his position.

Mr. Freeman thought a month would suffice.

Mr. Hughes remarked that there was no defence to the specific performance.

His Lordship: Oh, no. You agree to that, Mr. Freeman?

Mr. Freeman: Oh, yes. I want nothing except that the rails shall not be upset yet. Immediately we have considered your Lordship's judgment and decide to appeal, we will at once give notice.

Mr. Hughes said that although the parties were friendly in one sense, the plaintiffs wished to stand on their rights.

His Lordship observed that he thought the best thing would be that the order should not be passed for a fortnight, and asked what Mr. Hughes thought about the costs.

Mr. Hughes: I assume we get those.

Mr. Freeman agreed, and assumed that if the defendants decided to appeal, the rails would not be disturbed pending the appeal.

His Lordship said he did not know whether he had any power as to that, except by arrangement. The rails could be set right again even if they were disconnected.

Mr. Hughes: Of course the completion ought to have been some time ago, and the defendants had been running the tramways in the meantime and taking the profits. The plaintiffs ought to have an account of the profits.

Mr. Freeman: I perfectly agree—as there have been no profits there is no objection.

His Lordship said it would be put in the order that the plaintiffs were entitled to an account if they chose to take it.

Mr. Hughes said he assumed the plaintiffs did not pay any interest on the purchase money from the time they tendered the money.

Mr. Freeman did not agree to that. The purchase money was never legally tendered at all.

His Lordship, addressing Mr. Hughes, said he did not think that the mere dismissal of the counterclaim would do for him. He had better have a decree for specific performance, and the counterclaim would be dismissed with costs, the defendants to pay the costs of the action.

Order accordingly.

National Telephone Company *v.* Gulliver.

In the Westminster County Court on Monday this case, the facts of which were reported in the Electrical Review of the 23rd ult., came before his Honour Judge Lumley Smith, Q.C., by way of an application on behalf of the defendants, Messrs. Gulliver & Co., Limited, for leave to appeal.

Mr. Crompton Smith was counsel for the plaintiffs, and Mr. Minton-Senhouse for the defendants.

After a good deal of argument between counsel, his Honour said he could not set aside the finding of the jury, but did not see why the case should not go to a higher Court. He gave leave to appeal.

Cunnington *v.* Fraser Bros.

In the Westminster County Court on Thursday, his Honour Judge Lumley Smith, Q.C., and a jury tried the case of Cunnington and Co. *v.* Fraser Bros. Plaintiffs, electricians in St. Martin's Lane, fixed for the defendants, billiard table makers, two electroliers at the German Athenæum Club, for which they charged £14 2s. 9d. It was admitted that one of them fell down, but that was no fault of theirs, as they were directed to fix them in a certain manner, and what defect there might be was not their fault. The defence was that the proper charge should not have exceeded £8, and that the cost of refixing the electroliers was 30s., which they counterclaimed for.

The jury found for the plaintiffs for the amount claimed, and also on the other counterclaim, and judgment was given accordingly, with costs.

Killarney Electric Lighting Company.

In the Dublin Courts on November 28th, the case of Crompton and Co. *v.* Killarney Electric Lighting Company was heard, when an application on behalf of plaintiffs was made for liberty to mark final judgment for £35 alleged to be due for hire of a dynamo and other electrical plant supplied to the defendants. Defence was made on the ground that there was a counterclaim for repairs to machinery, &c. The Court granted the application.

Coventry Gas Fitting, Electrical and Engineering Company, Limited.

In the Chancery Division of the High Court of Justice on Wednesday (December 5th) a petition, presented by W. A. Davis and another, for the winding-up of the Coventry Gas Fitting, Electrical and Engineering Company, Limited, came before Mr. Justice Cozens-Hardy. Mr. Mark Romer, for the petitioners, who were creditors and debenture holders, said the petition was before Mr. Justice Wright on October 25th, and it was then stated by counsel that the directors were considering a scheme of reconstruction under which the petitioners would be paid in full. The company had passed resolutions for voluntary winding-up, and approval had been given to the scheme of reconstruction. He was quite willing to consent to the petition standing over for six weeks, so that the details of the scheme for reconstruction might be fully worked out.

Mr. Buckmaster appeared for creditors, and he did not oppose

the adjournment on condition that liberty was given to apply to restore the petition at an early date, if it was found that the proceedings for reconstruction were not being properly pursued.

Mr. Pollock appeared for the company.

Mr. Justice Cozens-Hardy allowed the adjournment until the second petition day of next sitting, and gave liberty to apply.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Dec. 5th, 1899.			Week ending Dec. 4th, 1900.		
Alexandria		Value £570	Amsterdam		Value £27
,,	Teleg. mat.	51	Antofagasta.	Teleg. mat.	157
Amsterdam		50	Auckland		54
Bangkok		128	Bombay		195
Beira.	Teleg. instruments	48	Calcutta		1,270
Bilbao		56	Cape Town		377
Boca.	Teleg. mat.	222	Colombo		46
Bombay		16	Copenhagen		13
Boulogne		70	,,	Teleg. wire	109
Brisbane		265	Demerara.	Teleg. mat.	996
,,	Teleg. mat.	649	Durban		315
Buenos Ayres		245	East London.	Teleg. mat.	346
,,	Teleg. mat.	118	Fremantle		444
Calcutta		705	Gothenburg.	Teleg. wire	22
,,	Teleg. wire	47	Halifax.	Teleg. paper	164
Cape Town		200	Hamburg.	Teleg. mat.	300
Chinde.	Teleg. mat.	941	,,	Teleg. wire	45
Colombo		38	Malta		219
Durban		1,722	Melbourne		164
East London		50	,,	Teleg. mat.	1,589
Fremantle		13	Nordenham.	Teleg. cable	1,000
Hamburg		330	Ostend		696
Hong Kong.	Teleg. wire	82	Penang.	Teleg. mat.	156
Madras		91	Port Elizabeth		100
Malta		143	Rio Grande.	Teleg. mat.	60
Mauritius		23	Rio Janeiro		31
Melbourne		427	,,	Teleg. mat.	801
Montreal		116	,,	Telephones	50
Novorossisk		80	Rosario		58
Ostend		118	Rotterdam.	Teleg. wire	21
Perth		93	St. Petersburg		30
Port Elizabeth		35	Santiago de Chili		213
Port Said		366	Santos.	Teleg. mat.	84
Rotterdam		920	Sydney		1,122
Santos		62	,,	Elec. lighting machnry.	3,125
Shanghai		530	Valparaiso		55
Singapore		84	Wellington		64
Stockholm.	63 T. teleg. wire (Value not declared)				
,,					
Sydney		1,144			
Yokohama		400			
	Total	£11,257		Total	£14,443

Foreign Goods Transhipped.

Buenos Ayres.	Elec. mat.	Value £43	Brisbane.	Teleph. appar.	Value £1,012
,,	Teleph. mat.	90	Hamburg.	Elec. mat.	205
Flushing.	Elec. goods	80			
Perth.	Elec. motors	967			
	Total	£1 130		Total	£1,217

Arbitration.—On Tuesday, Major Cardew (of Preece and Cardew) sat at 13, Queen Anne's Gate, Westminster, as arbitrator in a cause between the Corporation of Lynn and the Chloride Electrical Storage Syndicate, of Manchester. The syndicate carried out certain work for the Corporation, and charged £1,147, all of which had been paid, with the exception of £301, the amount in dispute. The arbitrator said he would consider the case as put before him.

Bankruptcy Proceedings.—The *London Gazette* contains notice of intended dividend in *re* A. W. Hirst, electrical engineer, West Croydon.

Liquidations and Dissolutions.—The Nuneaton Electric Company, Limited, on November 10th and 26th passed resolutions winding up voluntarily. Mr. H. B. Harris, of Nuneaton, is liquidator.

Messrs. J. T. Niblett, M. Sutherland, and E. Marcuson (Niblett, Sutherland, and Marcuson, electrical engineers, Chandos Street, W.C.) have dissolved partnership as from November 23rd.

Books Received.—*Science Abstracts* for November. London: E. & F. N. Spon, Limited. 2s.

"Fowler's Mechanical Engineer's Pocket-book, 1901." Edited by W. H. Fowler. Manchester: The Scientific Publishing Company. 1s. 6d. and 2s. 6d.

Lists. — The International Electric Company are sending out a circular of their patent high voltage key-holder, the switching mechanism of which is entirely enclosed by the china insulating body. The handle will actuate the switch only when turned to the right, turning to the left rendering it inoperative.

Messrs. S. Z. de Ferranti, Limited, have issued a pamphlet (No. 116) in which the Ferranti arc light system (rectifiers and switchboard) is described and well illustrated.

Messrs. Ernest F. Moy, Limited, send us an illustrated list of their Acme patent switches (in cast-iron cases).

Pamphlet.—A neat little pamphlet has been issued by Mr. J. N. Stephens, district electrical engineer for the National Electric Wiring Company, Limited, at Peterborough, giving useful information, in popular language, on electric lighting and power. We are informed that the company is doing the bulk of the work of installation in the cathedral city.

Dowsing Electric Radiator.—The Dowsing Radiant Heat Company, Limited, are supplying several new designs of their luminous electric radiators, the general principle of which is already familiar to our readers. They are called the "Bright Sunshine.' The one we illustrate (Type 423) is square type coppered all over and

has brass pillars and ornaments. It is supplied with four luminous heat lamps and two switches as shown. This type is recommended for the heating of public halls, waiting rooms, offices, and so on. The standard size (four lamps) is stated to consume one unit of electricity per hour, but they may be turned down to one half if required.

Electric Lighting and Tramway Powers.—The following further notices of applications for electrical powers appeared in the *London Gazette* for November 27th and December 1st:—

Electric Lighting.—Pokesdown (Bournemouth and Poole Electricity Supply Company); Benwell and Fenham (U.D.C.); Rugby (U.D.C., various, supply of electric fittings, also supply of electricity to adjoining districts); Dover (Corporation, purchase of gas and electric light companies' undertakings); Marylebone (Marylebone Electric Supply Co., Ltd.); Marylebone (by the Borough Council); Barry (U.D.C.); Teddington, Hampton, Hampton Wick and Ham (Richmond [Surrey] Electric Light and Power Company); Shildon and East Thickley (Durham) (J. D. Milburn, A. Scholefield, C. W. Fairweather, and S. V. Brown, carrying on business as the Northern Counties Electricity Supply Company); Shipley (U.D.C.); Handsworth (Northern Counties Electricity Supply Company); Benfieldside (Northern Counties Electricity Supply Company); Consett (Northern Counties Company); Annfield Plain (Northern Counties Company); Norton (Northern Counties Company); Thornhill (Northern Counties Company); Heston and Isleworth (Richmond [Surrey] Electric Light and Power Company); Sittingbourne (County of Kent Electrical Power Distribution Company); Goole (U.D.C.); Alnwick (Northern Counties Company); Neath, Briton Ferry, and Aberavon (Electrical Power Distribution Company); Pickering (Northern Counties Company); Pwllheli, Nevin and Porthdinllеyn light railways (North Wales and District Light Railway and Electric Power Syndicate); Pudsey (Corporation); Birstall (U.D.C.); Ynyscynhaiarn and Criccieth districts (also purchase of the Portmadoc, Beddgelert and South Snowdon Railway, Northern Counties Traction Company); Britonferry (U.D.C.); Bromsgrove (G. G. Brodie, C. Steer and W. Whitehouse); Cheshunt (U.D.C.); Macclesfield (Electrical Power Distribution Company); Dorking (County of Surrey Electrical Power Distribution Company); Skipton (U.D.C.); Stoke Newington (North Metropolitan Electrical Power Distribution Company, Surrey House); Ashton-in-Makerfield (U.D.C.); Neath (Rural D.C.); Aspull (U.D.C.); Rickmansworth (N. M. Electrical Power Distribution Company); Macclesfield (Corporation); Stratford-upon-Avon (Corporation); Frome (U.D.C.); Wellingborough (U.D.C.); Cannock (U.D.C.); Mountain Ash (U.D.C.); Pontypridd (U.D.C.); Todmorden (U.D.C.); Newbury (Urban Electrical Supply Company); Warwick (British Electric Traction Company); Worsley (U.D.C.); Isle of Thanet (rural, Isle of Thanet Electric Tramways and Lighting Company); Llandaff and Dinas Powis (Rural Council); Deptford (County of London and Brush Company); Rishton, Great Harwood, and Clayton-le-Moors (C. Chadwell); Lewisham and Penge (Lewisham and District Electric Supply Company); Ince-in-Makerfield (U.D.C.); New Hunstanton (U.D.C.).

Electric Tramways and Light Railways.— Derby (Corporation, various powers); Sandgate, Cheriton, and Folkestone (Sandgate and Hythe Electric Company, Limited, Donington House); Bexley and district (U.D.C.); Wimbledon (U.D.C.); Weston-super-Mare (Weston-

super-Mare and District Electric Supply Company, Limited, Surrey House, London); Middleton and Chadderton (Middleton Corporation and Chadderton U.D.C.); Crompton (U.D.C); Dover (Corporation new tramway along new street); Gosport (Portsmouth Street Tramways Company); Potteries (light railways extensions, Potteries Electric Traction Company); Shipley (U.D.C.); Isle of Thanet (amendment of 1898 light railways order, extension of time &c., Isle of Thanet Electric Tramways and Lighting Company); Leamington (Leamington and Warwick Tramways and Omnibus Company); Pontypridd and Rhondda Valley (British Electric Traction Company); Birkdale (U.D.C); Watford and district (new company); Royton (U.D.C.); Manchester Corporation; Pontypridd (U.D.C.); Worcester (extensions, Worcester Tramways, Limited); Gateshead and District (Gateshead and District Tramways Company, additional capital); Warrington and Northwich (light railway, Brunner, Mond & Co., and others); Folkestone (Corporation), two applications; Rhondda Valley (light railways, extensions and windings, British Electric Traction Company); Colchester (Corporation); Northampton (Corporation); Ashton-under-Lyne (Corporation); Denton (U.D.C.); Crewe (Corporation; light railways); Canterbury, Whitstable and Herne Bay (light railways, O. W. Bowen).

Electric Railways.—City and West End Railway: underground from Cannon Street to Hammersmith; Brompton and Piccadilly Circus Railway (extension of line and time) (Brompton and Piccadilly Circus Railway Company); City and North-East Suburban electric railway (new company); King's Road Railway (underground electric, St. George's, Hanover Square, Chelsea, and Fulham (new company); Piccadilly and City Railway (underground electric from Brompton and Piccadilly Circus Railway (Westminster) to Gracechurch Street, E.C., new company); Charing Cross, Hammersmith and district (underground electric, new company); West and South London Junction Railway (underground electric, Paddington to Kennington, new company); North-East London Railway (underground electric, City to Tottenham, Walthamstow and Leyton).

Electric Power.—Midland Electric Power Distribution and Lighting (Midland Electric Corporation, for extensions, to include Stafford and Worcester).

The applications last year were more numerous than they are this year. The tramway Bills last year were 31 against 26 this year, and the electric lighting provisional orders 112 against 103 this year.

Scotch Provisional Orders.—Applications have been made to the Secretary for Scotland for provisional orders with the following titles:—Caledonian Electric Power Company; Clyde Valley Electrical Power; Clydebank Tramways; Falkirk and District Tramways; Glasgow Corporation (tramways and general); Paisley District Tramways; Paisley Police Public Health and Tramways.

Fatal Electric Shocks.—Mr. Frederick J. Down, of Harpenden, Herts, writes to us as follows on this subject:—"With reference to the several recent casualties in central stations from accidental contact with exposed parts of the switchboards or other high tension apparatus, I beg to say that by lapping such parts with a special cured rubber strip or splice, such as I am now supplying, they would be rendered quite harmless. I may say further that when such material is properly applied, and by slightly warming after each lap or layer, an actual rubber tube results, giving an insulation resistance well up to that of the usual classes of covered conductors in the market. For bus bars, &c., where such lapping cannot be applied without dismantling the switchboard, my armalac varnish, or paint, will also serve well. The makers claims that it gives a resistance equal to the puncture strain of 1,500 volts for each $\frac{1}{1000}$ of an inch in the thickness of the films in which it is applied, hence its great success amongst machine builders here and elsewhere. Whilst, however, calling attention to these most successful materials, I quite agree with the correspondent who wrote about these accidents and suggested that, when possible, gear more modern and carefully designed, should be brought into use as the most certain preventative; still, where such drastic alterations cannot be carried out, the before-mentioned means of insulation may appeal to the engineers of such stations as the next best method of guarding their staff from similar mishaps."

Foreign Steam Engines.—We have received from Mr. J. P. Phibbs a catalogue of the Ateliers Carels Freres, of Ghent. This firm are the makers of the well-known Sulzer engine. It employs equilibrium double-beat valves for both admission and exhaust, and has a good record for steam consumption. The firm also make locomotives both of Belgian and English patterns, the English pattern being modelled very closely on English practice, needless to say, with great improvement of appearance upon the hideous Belgian models. The view of the foundry shows an excellent building, and the catalogue is well got up.

Notice.—Messrs. W. Wilson & Co., electrical engineers, of Middleton, near Manchester, ask us to state that "The Middleton Electric Light and Power Company," of which they are the owners, is a distinct and separate undertaking, and is not connected in any way with the Middleton Corporation electric lighting scheme, now in progress.

Personal.—Our New York namesake says that "Mr. T. J. McTighe, the well-known electrical engineer, has returned from a short business trip to London, where some important engineering and manufacturing propositions in which he is interested were closed."

Smoke Prosecution.—At Lambeth last week Mr. Hopkins heard a series of 10 summonses taken out by the Lambeth Borough Council against the South London Electric Supply Corporation in respect of a nuisance alleged to be caused by the issue of dense black smoke from the shaft of the company's works in Bengeworth Road, Loughborough Junction. For the defence it was denied that any dense black smoke issued from the shaft on the dates in question, and some expert evidence was called. The shaft, it appeared, is 180 feet in height, and the boilers are fed by mechanical stokers. Mr. Hopkins adjourned the further hearing of the summonses for a fortnight.

Trade Announcement.—Messrs. A. Pank & Son, of Bedford Street, Norwich, have purchased the business, plant, &c., of Messrs. Riches & Co., engineers, &c., of Duke's Palace Ironworks, in that city.

Water-Softening Plant.—Orders for the "Archbutt-Deeley" water-softening plant have been placed with Messrs. Mather & Platt, Limited, by the Electrical Power Distribution Company for their works at Sutton, and by Messrs. Albright and Wilson, Limited, chemical manufacturers, of Birmingham.

ELECTRIC LIGHT AND POWER NOTES.

Barry.—The U.D.C. purposes applying for a prov. order to establish a system of electric supply in the district.

Blackburn.—Owing to a short circuit on the mains, one of the generators in the Corporation electricity works broke down last week, and there was a temporary stoppage of supply.

Burnley.—The Gas and Electricity Committee of the Burnley Corporation propose to extend the electrical mains in their area, with a view to supplying electricity to private consumers. The Committee intend to do the underground wiring, so that when the tramways are constructed, it will not be necessary to again take up the streets. The estimated cost of the extension is £5,400.

Cardiff.—At a meeting of the Electrical Committee last week the resignation of Mr. Appelbee, chief electrical engineer, was accepted. Mr. Appelbee has been appointed chief of the electric staff at Ashton-under-Lyne. It was agreed that Mr. Appelbee be liberated from his engagement at the end of the year instead of having to serve his three months' notice. Thirty applications for the position of mains superintendent were considered. The commencing salary is £150 per annum.

The Tramway and Electrical Committees of the Corporation recently received the reports, drawn up by Messrs. Appelbee and Ellis, on the supply of electricity in Cardiff. Both engineers favour direct current. Mr. Ellis advocates the centralisation of the whole of the direct current supply at the new power station at Roath, retaining the present alternating plant for the supply of outlying districts. Mr. Appelbee had previously recommended the establishment of a direct current station, and this he adheres to.

Colchester.—Mr. A. R. Sillar terminated his engagement with Messrs. Siemens Bros. as resident electrical engineer at Colchester on Friday, and on Saturday he transferred his services in the same capacity to the Colchester Corporation.

Cowes.—The U.D.C. has resolved to transfer its electric lighting prov. order to the Isle of Wight Company, on condition that Messrs. Edmundson's Electricity Corporation pay the cost of obtaining the order.

Crayford.—The Board of Trade has revoked the 1899 electricity supply order.

Croydon.—The C. Council has adopted a free wiring scheme, and will borrow £5,000 as a first instalment for the purpose.

Cults.—In Aberdeen Sheriff Court on Saturday, Sheriff Crawford heard an appeal in the action at the instance of the trustees of the late John Cameron, contractor, Cults, against P. C. Middleton, Limited, electrical engineers, Cults, to prevent the latter from carrying on their works at their electrical station at Cults, which, it was alleged, constituted a nuisance. The case came before Sheriff Burnet some time ago, when his lordship issued an interlocutor in favour of the pursuers. That decision was now being appealed against. After hearing the arguments the Sheriff remarked that the case was an important one, and that he would take time to consider it. He, therefore, took the appeal to avizandum.

Dorking.—Four firms tendered for the Council's provisional order, but no definite action has yet been taken.

Eccles.—The Electricity Committee of the Corporation has recommended that the electrical engineer be instructed to prepare a scheme for the extension of the electric light undertaking, with a view to the supply of electrical current for tramway purposes and for the lighting of the whole of the public lamps of the borough, in addition to meeting the increased demand by private consumers.

Edinburgh.—The E.L. Committee of the Edinburgh T.C. last week agreed to recommend that application be made to the Secretary for Scotland for his consent to borrow a further sum of £76,000 for the execution of capital works. This will make a total of £700,000 for which borrowing powers have been authorised in connection with the electric lighting undertaking in Edinburgh.

Faversham.—The U.D.C. has appointed Mr. Talbot, city engineer of Nottingham, to give a preliminary report and advice on the electric lighting of the district for the sum of 25 guineas.

France.—The proposal for the establishment of a central electrical supply station for Gex (Ain-France) is now assuming definite shape, and it is proposed to utilise the water course of Journans. A reservoir capable of containing water varying in height from 33·75 to 39·50 metres and having a capacity of 800,000 cubic metres will be requisitioned, giving a pressure of 11 atmospheres. The conduit leading the water to the turbines will be 600 mm. bore and 1,300 metres long. The head of water will be 91 metres. The available power is 350 H.P., but for the moment only four electric generators will be installed. Two of the groups will be requisitioned for the traction of the Ferney-Gex tramway, and two others of 80 H.P. will supply energy for lighting and motive power in the town of Gex. The engineer, Mr. Rolland, estimates the cost at £15,200, or £35 per H.P.

Gillingham.—The D.C. has just decided that an agreement be entered into with the local electric lighting company at New Brompton for lighting the High Street with arc lamps. The cost is to be £18 per annum per standard.

Helensburgh.—The T.C. last week decided to abandon the idea of obtaining a provisional order for elec. lighting, and intend to obtain borrowing powers for their gas undertaking.

Heywood.—Mr. Sandford Fawcett, an inspector of the L.G.B., held an inquiry last week in reference to the application of the T.C. to borrow £17,000 for the purpose of electric lighting. Evidence was given by the borough engineer, electrical engineer, and others. There was no opposition.

Leeds.—The Lighting Committee of the City Council last week agreed to recommend the acceptance by the Council of tenders amounting to £72,572 for the extension of the electric light station on a site already provided, and to advertise for tenders for machinery for the new buildings. The Committee also decided to recommend the provision of a third 600-KW. two-phase generating set, and that the Corporation proceed with the laying of the main across Monk Bridge, with a view to supplying electric current for light and power purposes in the district south of the river.

London.—FINCHLEY.—The N.M. Electrical Power Distribution Company have decided not to proceed with their application for a provisional order for this district in the present session.

KENSINGTON.—At the last meeting of the Board of Guardians the E.L. Committee reported that it was desirable to light the workhouse, infirmary and office buildings in Marloes Road by electricity. The report was adopted, and the board decided to instruct Prof. Robinson to prepare and submit a complete plan and specification for the buildings, machinery and plant required, at an estimated cost of £12,500.

LAMBETH.—The Borough Council has adopted a recommendation in favour of authorising the town clerk to take proceedings against the South London Electric Supply Corporation for the non-fulfilment of their contract to destroy the dust of the borough. As the result of the proceedings brought by the Vestry against the corporation for creating a nuisance, the magistrate at Lambeth Police Court insisted that Welsh coal should be used. Thereupon the Electric Corporation's representative, despite the contract with the Vestry, intimated that they would take no further deliveries of dust. Since that decision, the borough surveyor has had to provide for the refuse being taken away by barges, and the corporation, in reply to a reminder that they are liable for penalties for non-fulfilment of their contract, wrote to the Borough Council pointing out that it was the Vestry that induced the magistrate to prevent the further use of the destructor, and thus, by its own act, put it out of the power of the corporation to carry out its contract. They, therefore, insisted that the Borough Council must itself deal with the dust, and, moreover, compensate the corporation for depriving it of the use of dust as a fuel.

ST. PANCRAS.—The Borough Council have in contemplation a scheme for a large extension of feeding mains. The chief electrical engineer has reported that it is important that an early start should be made in the spring to lay additional mains, which practically means an increase of all the feeders controlled by the King's Road generating station. With regard to the original feeders installed in connection with this station, in no case was there a return or centre wire provided, the theory being that it would be sufficient to balance one consumer against the other, and so obtain an equal potential between the negative and the positive and centre wires of the distributors. This theory, however, is not borne out in practice, as the positive and negative lighting loads vary each night in the week; consequently it is not possible to give a satisfactory regulation at the feeding points. All the feeders which it is proposed to lay down are to be provided with centre wires, also a three-core pilot wire to each for indicating at the generating station the voltage at the feeding points. A careful estimate has been made of the probable lighting required in the districts to be covered by the new feeders, which will be proportioned to deal with about half of the ultimate load. It is hoped that the extensions will serve for five years, when a readjustment will probably be necessary and more copper have to be put in. As showing the difficulty of estimating the lamps required in a district, 1,300 were contemplated in the Highgate scheme. The flats which have recently sprung up in this locality will now absorb another 1,320 lamps. The work of extending the new mains will, it is hoped, be commenced in February next, and the estimated cost is £29,390. Extensions sanctioned by the late Vestry are about to be commenced, and a tender of Callender's Cable and Construction Company, Limited, has been accepted for the supply of cables at a cost of £2,597.

North Metropolitan District.—The united Councils of Tottenham, Edmonton, Enfield, Wood Green, Southgate, and Friern Barnet have framed their Bill for presentation to Parliament in favour of a joint scheme for the supply of electricity within their respective districts, and the whole matter has been conducted with great unanimity everywhere excepting Wood Green. On Friday last the statutory resolutions were passed to proceed with the Bill, the cost of which may be anything from £5,000 to £10,000. At the meeting of the Wood Green Council a letter was read from Mr. Littler, who has been chairman of the local authority since its formation in 1888, resigning his seat on the Council, giving as his reasons for this step that the proposal was inimical to the interests of the parish. The resignation was accepted, and the necessary instructions to proceed with the Bill were given. It may be mentioned that this course is the outcome of the many applications by electrical power companies for powers to supply current in these districts, and the various local authorities concerned have taken 12 months to fully discuss and agree on all the details of the scheme.

Rothesay.—The electric lighting of the burgh not being quite to the satisfaction of the T.C., they have decided to ask the contractors to maintain it for another 12 months.

Ryde (I.O.W.).—The new Council has rescinded the resolutions of the previous Council relating to electric lighting, and intends asking the Board of Trade to allow it to transfer the order.

South Shields.—The E.L. Committee recommends the increase of Mr. Jeckell's salary from £350 to £400.

Southampton.—Mr. Howat has been promoted to be second engineer at the electricity works, and Mr. H. A. Pearson has been appointed third engineer. The continuous current plant being nightly overloaded, in consequence of the non-delivery of plant to time, the Council has resolved to inform Messrs. Ferranti that the penalty clause will be strictly enforced.

Spain.—It is reported from Cartagena that a company is in course of formation with the object of establishing a large central station in that town, which will supply current for lighting and power purposes, not only in Cartagena, but also to a number of small towns in the district.

Sunbury.—Messrs. Edmundson's Electricity Corporation, whose application for a provisional order the Council had decided to oppose, do not intend to proceed with their application this session as they have been unable to obtain the consent of other District Councils in the neighbourhood. In the meantime they propose to take steps for the construction of electric lighting works at Twickenham.

Swansea.—The electric lighting works are now almost completed, and the E.L. Committee is considering the question of wiring the houses of customers. Some time ago it was agreed to allow this work to be done by the National Free Wiring Company. The agreement was, however, withdrawn; but the advisability of re-entering into a contract with the company has now been rediscussed, it being stated that the company was now prepared to accept the Corporation terms of 1s. per lamp per annum. Ultimately it was decided to ask the company for terms more favourable to the consumers.

Wales.—At the adjourned conference of delegates of Councils of the Monmouthshire Western Valleys, held at Abercarn on Monday, to consider the electric lighting scheme, only Abercarn and Risca were represented. The Abertillery Council has decided not to share in the expense of an expert, and Nantyglo and Blaina Council will take no action in the matter. It was agreed to recommend the Abercarn and Risca Councils to obtain expert evidence upon the desirability of providing a joint electrical installation.

West Hartlepool.—Col. Durnford, L.G.B. Inspector, held an inquiry last week with respect to an application by the T.C. to borrow £19,625 for electric lighting purposes. The town clerk explained that a considerable portion of the excess expenditure upon the original estimate was due to the rise in the price of materials between the time the estimate was given and the letting of the contract. The buildings had cost £3,600 more than the estimate. Of the £19,000 required, £7,112 was for extension of mains, and £2,707 for probable extensions during the next 12 months.

Willesden.—At a meeting of the D.C. on Tuesday last, it was reported that the engineer had received the bills of quantities in connection with the main and sub electricity stations. The Council decided to apply to the L.G.B. for sanction to a loan of £52,550 for use as follows:—Buildings, walls, sites, works, chimney shaft (main station), £36,104; tenants' compensation, £121; cost of road, £325; coal sidings, £2,500; offices and sub-station, £13,500.

Worthing.—There were 100 odd applications for the position of electrical engineer to the Corporation. Mr. G. Porter, of the Westminster Electric Supply Corporation, is recommended by the committee.

York.—The Minster has been lighted throughout with electricity, about 170 lamps of 32-C.P. each being used.

ELECTRIC TRACTION NOTES.

Amsterdam.—The Communal Council of Amsterdam has unanimously voted a sum of £520,000 for various electrical works, including the construction of a central power station for an electric tramway system 30 miles long. This station will also supply current for lighting and motive-power purposes. The station will be capable of 8,000 H.P., 6,000 of which will be for immediate use. In the near future, however, the possibilities of the station will be largely increased. The power station will be built on the site of the old *entrepôt* dock. A sum of £144,000 will be spent on the power station and overhead wires, £288,000 on the tramline, and £88,000 on the underground conduits.

Antwerp.—The Belgian Chamber will shortly be occupied with the consideration of a project to be presented by the Government for the unification of all the Antwerp tramway companies, viz. :—

	Expiration of concession.
Tramway du Sud	1920
,, Nationaux	1911
,, Maritimes	1916
Omnibus d'Anvers	1916
Tramway-Omnibus	1941
,, Suburbain	1933
,, Anversois	1928
,, Rue d'Argile	1935

All these lines, which at present employ animal traction, will be compounded under the jurisdiction of one company, and the system worked throughout by electric traction with reduced fares. A concession will be granted to the new company till 1945.

Birkenhead.—The Woodside-New Ferry route of the Birkenhead electrical tramway system is rapidly approaching completion. The aim of the Corporation is to have the line working during the present month, and it is believed that this will be attained.

Bootle.—Colonel Trotter inspected the Derby Road and Rimrose Road tramway route last week, and approved it. This route consists of 1½ miles of double track with span wires.

Bristol.—The extension of the electric tramway system is now practically completed, and only awaits the approval of the Board of Trade. No date has yet been fixed for the inspection of the permanent way, but the electrical inspector inspected the power station, &c., this week.

Calais.—At the instigation of the Calais Tramway Company, Limited, the town of Calais has decided to extend the scope of its tramway service, and to replace the present horse haulage by electric traction. Part of the scheme has already been approved of by the authorities.

Canal Traction.—Electric traction has been tried with successful results on the Berlin Canal, Stettin, Germany. This canal is traversed annually by 25,000 boats, generally 40 metres long × 4½ metres beam, and carrying on an average 150 to 175 tons. It is likely, as an outcome of the successful trial, that electric traction may become fairly general on this waterway.

Cardiff.—Forty-eight applications were received for the post of chief assistant electrical engineer, and the following were invited to attend before the Tramways Committee:—Mr. C. T. Taylor, of Leeds; Mr. J. G. Livesay, Huddersfield; and Mr. C. E. Davies, Bolton. Mr. Davies has secured the appointment.

Darwen.—The T.C. has resolved that the salary of the electrical engineer be advanced from £200 to £250 per year, and that Mr. Clegg should also be given an honorarium of £50 for services rendered in connection with the conversion of the tramways from steam to electric traction.

Dublin.—In the Police Court on November 30th, the Corporation had 40 summonses against the Dublin United Tramways Company for neglecting to keep various streets sanded, to the danger of ordinary traffic. When the cases came on for hearing, it was announced that the Tramway Company had undertaken to in future keep the paving between the tramway lines and 18 inches on either side properly sanded, and had agreed to pay to the Corporation a sum of 50 guineas for costs of summonses, &c.; so they were withdrawn on these terms.

Electric Railway between Rome and Naples.—A demand for a concession for the construction and working of an electric railway has been presented to the Minister of Public Works in Rome through the Naples Prefecture. The line, which would be 315 kilometres in length, starting from Naples, would pass by Mondragone, Mentorno, Terracina, and Cisterna, and it is estimated that the trains would only take three hours to cover the whole journey. The electrical energy would be generated at hydraulic stations on the Volturno and other rivers *en route*. Owing to insufficiency of the plans, the matter has been referred back by the Government to the Prefecture at Naples, with the request that the engineers asking for the concession should complete the plans and studies on the spot.

Liverpool.—A revised scale of fares came into operation on the Liverpool electric tramway system on Saturday. The most important change has been the institution of a 1d. fare for travelling between the Pier Head and Belmont Road on what is known as the Cabbage Hall route. The distance is about 2½ miles. The Seaforth extension is expected to be ready for use by Sunday next. Work is being pushed on with the belt line, which will complete the circle round the city from north to south or *vice versâ*, by branch lines working to the east of the city.

Manchester.—Mr. C. H. Wordingham has prepared a report to the Electricity Committee in which (according to a summary in the *Manchester Guardian*) he deals at length with some of the statements in the report of the general manager which was recently presented to the Tramways Committee with regard to the supply of electrical energy for the working of the tramways. As regards the generating station in Stuart Street, Bradford, Mr. Wordingham says that although the Electricity Committee arranged for the purchase of the land in December, 1897, the purchase was not completed until October, 1898. There was then a further delay of six months on account of the Tramways Committee having under consideration the question whether it would not be better themselves to provide the electrical energy for driving the trams. He also states that details and plans were asked for from them, with an account of the dates when electrical energy would be required, and a definite order; but these have not been forthcoming. He replies to the statement that the Tramways Committee are pushing forward rapidly with the preparations for the taking over of the line by instalments, and also that the permanent way is being rapidly reconstructed, and says that, as a matter of fact, the Tramways Department themselves are hopelessly behindhand with this work. He describes the arrangements for the supply of energy to the different parts of the city, and says that his report of October 23rd clearly shows that the Electricity Committee will be prepared to furnish the energy for the first three tramway routes long before these routes are ready to take the supply. He deals with other work done by his department, and, in conclusion, says: "I have to say that I consider that the report of the general manager is so drawn as to leave the impression that the Tramways Committee will be quite ready with their lines so as to take current on the dates named in their communication of July 22nd, 1899, to the Electricity Committee, and that they will be prevented from opening the lines on the dates named in that communication on account of the Electricity Committee not being in a position to supply them with the necessary electrical energy. In point of fact, the Tramways Committee are already five months late with the first section, and have not begun the work of reconstruction of any one of the three remaining sections, while the Electricity Committee will be ready to supply the electrical energy to the first section some time before the Tramways Committee can be ready. What has happened in regard to the first section of lines may be expected to happen with the remainder, and it is by no means evident at the present time that the Electricity Committee will be greatly behind the Tramways Committee. Both Committees are engaged on very large and difficult schemes, and it will not be surprising if both find themselves in the position of having under-estimated the time required to carry them out."

Piedmont.—A concession has been granted for an electric tramway, which, starting from Brusasco (at the terminus of the present steam tramway from Turin) would proceed to Ozzano, a distance of 33 kilometres. The line is to be built with ordinary raised rails on one side of the national and provincial highway. The total length covered by the present concession is only 33 kilometres, but various branch lines hereafter to be constructed would nearly double this length of track. There being no water-power in the immediate neighbourhood, steam-power will be used to generate the electric energy for the propulsion of the cars, which for passenger traffic will have the motors directly mounted on the trucks, while for freight traffic electric locomotives will be used to draw the trains. The system proposed to be used is three-phase alternating, with two overhead trolley wires. The concessionaires of this line have also applied for a concession for a line from Brusasco to Ivrea, through another district not yet served by tramline or railway, and along the route of which there is a population of about 100,000 inhabitants. Another line studied by the same engineers, and of which the plans have been completed, crosses the line from Brusasco to Ivrea almost at right angles, the population along the route of which is about the same as on the Ivrea-Brusasco line. Sufficient water-power is available at three points on the routes to work the whole length of the present lines, amounting to some 90 kilometres, as well as extensions of about 30 kilometres more, surveys for which have already been completed. The maximum grades on these lines do not exceed 2½ per cent., save in one place on the Brusasco-Ozzano line, and the minimum curves have a radius of 35 metres. The maximum speed allowed is 30 kilometres per hour when fitted with continuous Westinghouse brakes, or 20 kilometres per hour when not so fitted. Owing to the construction allowed, *i.e.*, raised rails and sleepers with ordinary ballasting, on roads already constructed by the National and Provincial Governments, it is estimated that the complete cost of construction and equipment, including the hydraulic installations, will not exceed £4,000 per mile.

Roumania.—The Mayor of Ploeshli, Roumania, will, on January 23rd (January 10th, old style), proceed with an adjudication for the concession and construction of an electric tramway, which will traverse several streets in the town. Competitors must deposit a bond for £2,000.

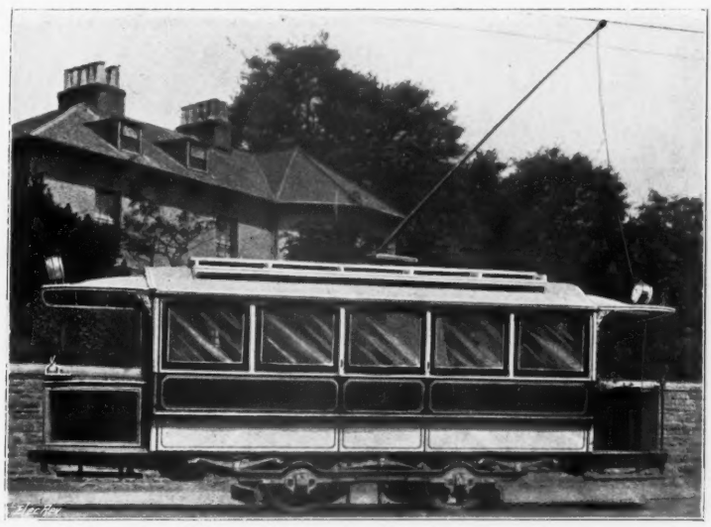
Southampton.—Increased traffic demands the purchase of six new cars. Trials have recently been made of a wire netting seat for the cars, and it is proposed to adopt such seats for all cars, at a cost of £200.

(*Continued on page* 913.)

SWANSEA ELECTRIC TRAMWAYS.

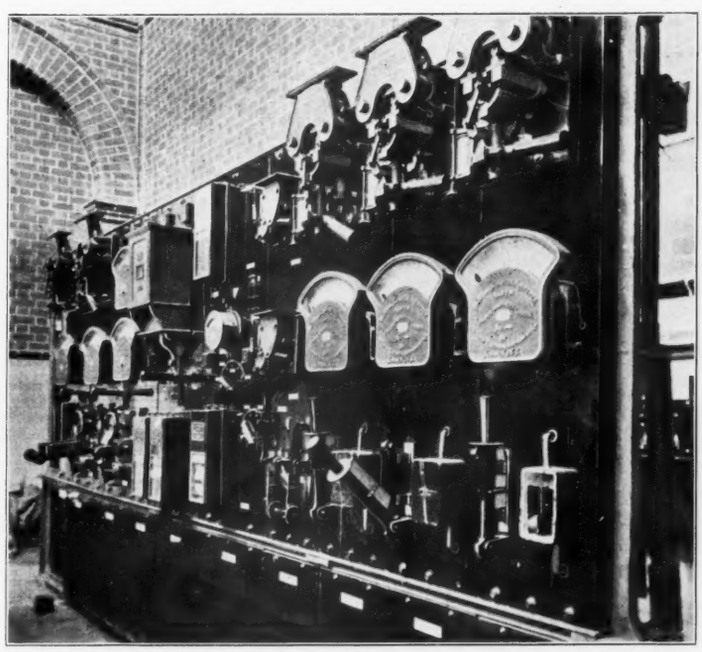
As we pointed out in our issue of July 6th last, Swansea claims the dual distinction of having been the first town in Wales to possess a steam railway, and of being again the first to inaugurate an electric tramway service. The latter was due to the enterprise of the British Electric Traction Company, which acquired most of the shares of the old tramway company in 1897.

The tramways, which have been entirely relaid, are 5½ miles in extent, consisting of 3 miles single and 2½ miles double track; they are divided into three sections—the Town section, the Swmbwrla, and the Morriston section. The new rails weigh 86 lbs. per yard, and are laid to a gauge of 4 feet 8½ inches.



View of Short Type of Car.

The power station is a brick building, situated in the old tramway depôt, St. Helen's Road, at the south-western end of the tramway system. The boiler house measures 37 feet 10½ inches × 39 feet 6 inches in plan, and at present contains two Babcock & Wilcox boilers of standard type, fitted with superheaters. Each boiler has a grate area of 38 square feet, and a heating surface of 2,010 square feet, while the superheater provides an additional heating surface of 226 square feet. The working pressure is 150 lbs. per square inch, and the normal duty 7,000 lbs. water per hour per boiler. The chimney is built of brick, and is 125 feet high, with an internal diameter of 4 feet 6 inches. A Green's economiser, with 160 tubes, is provided.



Main Switchboard.

The coal used is obtained from neighbouring coal mines, and is delivered in carts; water for boiler feed is taken from the town supply, while water for the Wheeler surface condensers is pumped up from wells.

The arrangement of the steam piping follows the American plan, branches from the boilers descending to a main header, from which risers are taken to the engines. Holden and Brooke steam separators are used.

The engine room is 64 feet 4 inches long × 29 feet 6 inches wide. There are two engines, of the Ball and Wood tandem compound horizontal condensing type, rated at 330 I.H.P. each, at a speed of 200 revolutions per minute. The cylinders are 15½ and 31 inches in diameter, and the stroke 16 inches. The speed is controlled by automatic expansion governors of the fly-wheel type.

The generators, which are coupled direct to the respective engines, are Westinghouse eight-polar compound machines, and are rated at 200-KW. each—*i.e.*, 400 amperes at 500 to 550 volts. The armatures are of the toothed-core barrel-wound type: the machines are identical with those installed at Norwich, which we described in our issue of July 27th, 1900.

A combined steam and motor-generator set is also installed, consisting of a 50-B.H.P. engine by Messrs. Alley & Maclellan, running at 450 revolutions per minute, coupled direct to two 20-KW. dynamos, one of 500, the other of 100 volts pressure. This appears to be a very handy combination; when the main engines are running the steam engine is disconnected, and the 500-volt machine drives the 100-volt dynamo for lighting and motor purposes, while at other times the small engine drives the pair of dynamos, giving both pressures, and thus fulfilling all requirements when the cars are not running.

A 10-ton overhead crane, supplied by Messrs. Carrick and Ritchie, traverses the engine room.

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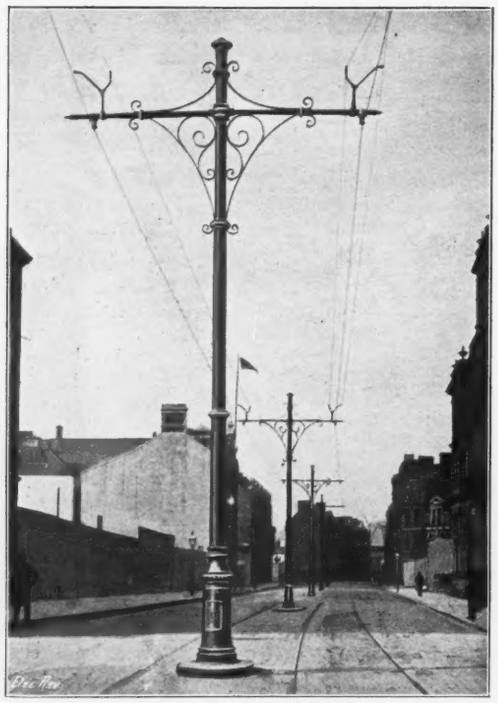
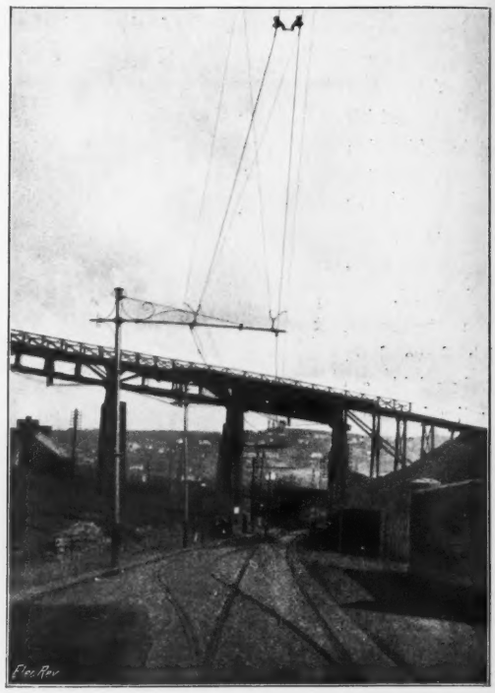
The switchboard consists of eight panels; two are generator panels, three feeder panels, and the remainder motor-generator and booster panels. The board was designed



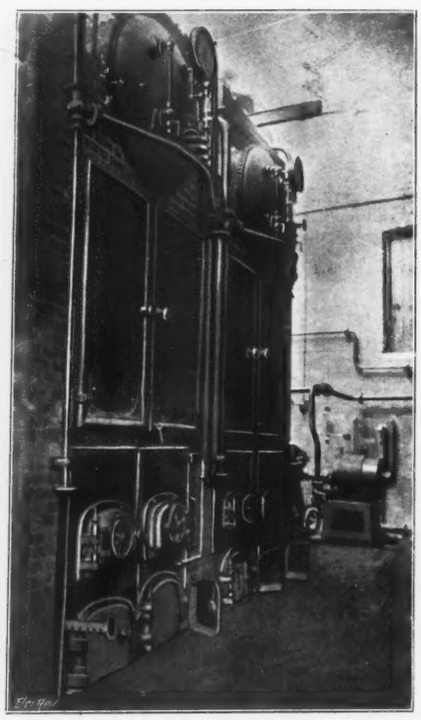
Centre Pole Suspension.



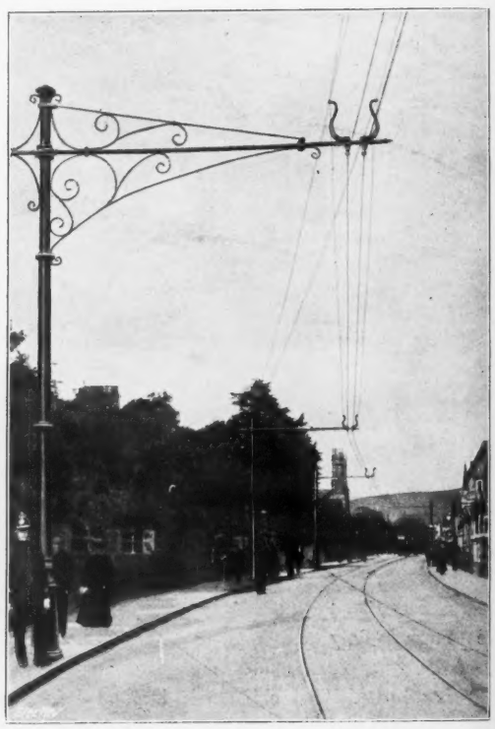
Tramway passing under Bridge.

and constructed by the General Electric Company, of Salford.

Each of the generator panels is provided with an illu-



Water-tube Boilers.



Side Pole Bracket Arm Suspension.

minated dial ammeter, of Weston's make, and an automatic circuit breaker, together with a main D.P. switch, which is interlocked with a two-way switch for short-circuiting the field of the generator, and is so arranged that the field circuit must be made before and opened after the main circuit.

The equalising of the generators is done by means of screw plugs (one on each generator panel), and the shunt regulating switches and resistances are mounted separately on standards behind the board, having only a hand-wheel and index (denoting the position of the switch contacts) on the face of the panels.

The instruments required by the Board of Trade for testing purposes are provided on a separate panel. A

"Electrical Review" List of Elec

OVERH

LOCALITY.	Lines owned by.	Track.	Gauge.	Weight of Rails per yard.	Character of Overhead Work.	Number of		Car Motors.	POW	
						Motor Cars.	Trailers		Boilers.	
			ft. in.							
(1) **Aberdeen**	Corporation	2¼ miles double, ½ mile single	4 8½	98 lbs.	1¼ miles centre pole, 1¼ miles span wire	12	—	2 30 h.p. Westinghouse	8 Babcock-Wilcox	Willa
(2) **Barking Town and Beckton**	Urban Dist. Cncil.	About 1⅝ miles..	4 8½	90 lbs.	Side pole	5	4	—	Babcock-Wilcox	W. H
(3) **Blackburn**	Corporation	4 miles	4 0	92½ lbs.	Bracket arms, centre and side poles	8	—	Siemens, two per car	Lancashire.....	Willa
(4) **Blackpool**	Corporation	3 miles double; 1 mile single; 4 miles double in hand	4 8½	96 lbs. and 95 lbs.	Bracket arms, with side and centre poles	26, extensions 15	—	2 G.E 52	—	2 Par 2 c
(5) **Blackpool and Fleetwood**	Blackpool and Fleetwood Tramroad Co.	6½ m. enclosed for high speed, 2 m. tramway	4 8½	98 lbs., 83 lbs., 56 lbs.	Bracket arm, centre and side poles, and span wire	30	3	2 G.E. 1000 (bogie trucks)	4 Lanc., 30 ft. by 8 ft.. and economiser	5 Mat ver 200
(6) **Bolton**	Corporation	31 miles single (14 miles new)	4 8½	100 lbs.	Mainly side brackets, span wire	70	—	Dick-Kerr and B.T.H.	—	2 1,0 Mu con
(7) **Bradford**	Corporation	22 miles	4 0	Girder 105 lbs., Dem'rbe 70½	Bracket arm suspension	53	—	Westinghouse, No. 49, and Dulait (Belgian)	12, of 5,720 h.p., Lancs. and marine, 1 water-tube	15, of Wil
(8) **Brighton and Rottingdean**	Brighton and Rottingdean Seashore El. Tr. Co.	3 miles, 2 tracks used as one, 18 ft. over all	Each track 2 8½	55 lbs.	Steel and wood poles, bridle suspension	1	—	4 G.E., 25 h.p.	—	
(9) **Bristol**	Bristol Tramways and Carriage Co., Ltd.	20 miles	4 8½	92½ lbs.	Side and centre poles, and span wire	51	15	2 G.E. 800 and 52	4 Lanc., mechanical stokers	4 250 Sey 200
(10) **Cardiff**	Corporation	6½ miles double, 1¾ miles single	4 8½	100 lbs.	Centre poles chiefly, side bracket, and some span wire	120	—	2 30 h.p. per car	4 Lanc., 30 ft. by 8 ft., Musgrave	4 Mus Cor 100
(11) **Carlisle**	City of Carlisle El. Tr. Co. Ltd.	7½ miles	3 6	86 lbs.	Bracket arm	12	—	2 25 h.p., Dick-Kerr	—	
(12) **Cork**	The Cork Tramways & Electric Ltg. Co., Ltd.	5 miles double, 2 miles single	3 0	86 lbs	Chiefly centre pole, with bracket arms	28	—	2 B.T.H , 27 h.p.	6 Babcock-Wilcox	3 Mcl Alli com
(13) **Coventry**	Coventry Electric Tramways Co.	5½ m. single and 5 m. single, Falk joints, steel slprs	3 6	84 lbs. and 65 lbs.	Cross suspension and side brackets	20	5	Each car 2 20 h.p., Westinghouse	2 172 h.p., 2 106 h.p., water tube	2 150 h ley rect 2 15
(14) **Darwen**	Corporation.....	2·84 miles double	4 0	95 lbs.	Span wire, rosettes and side poles	10 (bogie)	—	G.E. 52, West. 49 and 46	3 Lanc., 30 ft. by 8 ft., refuse destructor	Belliss h.p.
(15) **Devonport and Suburbs**	Devonport and District Tr. Co.	10 miles, mostly double	3 6	92½ lbs.	Side trolley and centre pole	20	—	G. E. 58	Babcock-Wilcox	Browe
(16) **Dover**	Corporation	3 miles single, 1½ miles double	3 6	87 lbs.	Side poles with bracket arms	16	—	2 G.E. 800, Walker 33S	2 water tube	2 Mc hori
(17) **Dublin and District**	Dublin United Tramways Company, Ltd.	44 miles double..	5 3	92 lbs.	Centre pole, span wire, and side bracket	300	—	G.E. 52 and 800, Dick-Kerr, 80 h.p.	12 Babcock-Wilcox, mechanical stokers and economiser	6 Allis cal t cond
(18) **Dublin and Lucan**	Dublin and Lucan Elec. Ry. Co.	6½ miles single, ½ mile double	3 6	50 lbs.	Side bracket	5	4	20 h p., Walker, type N.	2 Lancashire.....	2 Ball hori
(19) **Dudley, Stourbridge, and District**	Dudley, Stourbridge, and District E. T. Co.	8½ miles	3 6	87 lbs.	Span wire, centre pole, side brackets	44	—	2 G.E. 800, and Dick-Kerr	3 Lanc., 28 ft. by 7 ft...	3 175 hori com
(20) **Dudley and Wolverhampton** ..	British Electric Traction Co., Ld.	2½ miles single with loops	3 6	—	Bckt. arm, side trol., some span wire	13	—	G.E. 800 and Dick-Kerr	Babcock.....	Westin
(21) **Dundee**	Corporation	3⅝ miles double, ¾ mile single	4 8½	92 lbs. and 95 lbs.	Side and centre poles, with bracket arm and span wire, side trolley	20	—	Dick-Kerr	Lanc., 4 30 ft. by 8 ft., 4 24 ft. by 7 ft.	10 Wi
(22) **East Ham**	District Council	2½ miles double, 2⅜ miles single	4 8½	87 lbs.	Side poles, with bracket arms	10	—	Dick-Kerr	4 water tube	4 com dire
(23) **Giant's Causeway and Portrush**	Giant's Causeway and Portrush Electric Tramway Company	8 miles single ..	3 0	43 lbs.	Overhead trolley ..	4	4	T.H., 2 per car and Siemens, 1 per car	—	2 turb
(24) **Glasgow**	Corporation	Running, 5 miles double	4 7¾	100 lbs.	Span wire	47	—	General Electric and Westinghouse	3 Babcock-Wilcox	3 Mc tand revs
(25) **Guernsey**	Guernsey Railway Company	3 miles single ..	4 8½	40, 74, 82 lbs.	Bracket suspension	8	7	Siemens, and G.E. 800	1 Babcock - Wilcox, 2 loco.	2 comp
(26) **Halifax**	Corporation	16 miles	3 6	98 lbs.	Side poles and span wire	40	—	E.C.C., West., B. T. H.	Lanc. and water tube	Low high
(27) **Hartlepool**	General Electric Tram. Co., Ltd.	4½ miles single ..	3 6	65 lbs. & 87 lbs.	Side trolley (Dickinson)	15	—	2 15 h p. Walker, 2 E.C.C.	2 Galloway, 20 ft. by 6 ft., 1 Lancashire	3 Will pour
(28) **Hull**	Corporation	9 miles double, 1 mile single, centre groove rails	4 8½	96 lbs.	Bracket arm, centre and side poles, and span wire	66	—	Westinghouse, Siemens and G.E. 52	4 Lanc., 30 ft. by 8 ft. ..	3 Bell pour
(29) **Isle of Man**—(1) DOUGLAS, LAXEY AND RAMSEY	Isle of Man Tramways and Electric Power Co.	17½ miles double	3 0	56 bs. and 62½ lbs.	Bracket arm, centre pole	22 1 Loco	22 12 goods wagns	2 20 h.p. per car, 4 20 h.p. per car	5 Lanc., 20 ft. by 6 ft., 3 Galloway, 26 ft. by 6 ft. 6 ins.	5 Gall 90 h stro 180
(30) (2) SNAEFELL MOUNTAIN.....		5 miles double ..	3 6	56 lbs. 65 lbs. (cntr. rl.)	Do.	6	—	4 25 h.p. per car	4 Lanc., 26 ft. by 6 ft. 6 ins.	5 Ma com
(31) (3) DOUGLAS SOUTHERN	Douglas Southern Electric Tramways, Ltd.	4 miles	4 8½	—	Side trolley, bracket arms	8	8	2 25 h.p., G.E. 800	2 Babcock	2 Brow
(32) **Isle of Thanet** (MARGATE and RAMSGATE)	Isle of Thanet Elec. Trm. & Ltg. Co.	11 miles	3 6	—	—	—	—	B.T.H.	—	

Electric Tramways and Railways in the Un

ERHEAD TROLLEY LINES.

POWER STATION EQUIPMENT.				CAPITAL OUTLAY.				Date opened.	Tramways Manager.	Electrical Engineer.	Annual Car Mileage, and Passengers Carried.	Cost per Car Mile, Pence.	Ratio of Expenses to Receipts.	
Boilers.	Engines.	Generators.	Total capacity in KW.	Permanent Way.	Power Station.	Rolling Stock and Electrical Equipments.	Total.							
ck-Wilcox	Willans and Belliss ..	1 Bruce-Peebles, 200 kw.; 2 Holmes, 110 kw.	420	£20,330	*	£19,731	£40,061	Dec., 1899	D. Moonie..	J. Alex. Bell	—	6·39	—	£150,000 extension san progress. * Lighting
-Wilcox	W. H. Allen	Thames Ironworks	200	—	—	—	—	—	—	S. E. Britton	—	—	—	Consulting Engineer, W
ire.....	Willans and Belliss....	Siemens, Mather and Platt, and E.C.C.	*	—	*	—	£155,283	March, 1899	A. S. Giles ..	A. S. Giles..	169,942 c.m., 2,079,633 p.	6·62	56 %	Corporation now equip motor cars, each wit to carry 66 pass., on
—	2 Parsons steam turbines, 2 do. in hand	2 Parsons ..... 2 do in hand	250 400	—	—	Cost of conversion £11,000	—	Converted June, 1899	J. Lancaster	R. C. Quin..	318,885 c.m., 3,421,786 p.	—	—	Combined lighting and trolley system June, expenses, March, 190 battery, Hart Accu
30 ft. by 8 ft.. onomiser	5 Mather-Platt dir. cpld. vertical compound, 200 h.p., 165 r. p. m.	5 Mather-Platt, 6-pole shunt, 120 kw.	600	£110,170	£60,915 *	£23,824	£194,909	July, 1898	J. Cameron (and Sec.)	J. McMahon	516,354 c.m., 1,821,792 p	6·18	56·78 %	Two chloride batteries * Including overhead
—	2 1,000 h.p., 2 500 h.p., Musgrave vertical compound	2 600 kw., 2 300 kw., Mather-Platt 12-pole compound	1,800	£120,000 (about)	£40,000 (about)	£85,325 *	—	Jan., 1900	A. A. Day (Engineer)	—	6 months. 683,113 c.m., 8,575,140 p.	6·05	—	Combined lighting and * Cars, £34,825; over feeders, £18,000. Le
720 h.p., Lancs. arine, 1 water-	15, of 5,230 h.p., chiefly Willans	15 Siemens	3,189	£62,608	—	£37,737	—	July, 1898	C. J. Spencer	R. A. Chattock	391,644 c. m.	9·8	79·6 %	6 lines running. Seve Combined lighting a
—	—	—	60	—	—	—	£35,792 *	Nov., 1896	M. Volk	M. Volk	5,756 c.m., 100,081 p.	—	70·3 %	60 kw. G.E. direct transforming from 2
, mechanical	4 250 h.p, McIntosh-Seymour, direct coup., 200 revs. p. m.	4 G.E., 150 kw..... Negative boosters	600	—	—	—	—	Oct., 1895	Samuel White (Managing Director)	J.C.Robinson, H. F. Parshall (consg.)	—	—	—	40 miles, changing to station now erecting
30 ft. by 8 ft., ve	4 Musgrave vertical com. Corliss cond., 500 h.p., 100 revs. per min.	4 Westinghouse, 300 kw., direct on shaft	1,200	—	—	—	—	—	Arthur	Ellis	—	—	—	To open January 1st, 1
—	—	—	—	—	—	—	£100,000	June, 1900	G. Cook (and Secretary	—	* 73,389 c. m. * 833,408 p.	—	—	Energy suppld. by Corp & Co. * June 30th t
k-Wilcox	3 McIntosh-Seymour, 2 Allis, horiz. tandem compound condg.	B.T.H., 6-pole comp., direct coupled	1,400 *	—	*	—	—	Dec., 1898	W. G. Davies	C. H. Merz (and Sec.)	About 750,000 c. m., 5,500,000 p	—	—	Tudor storage battery lighting and traction
., 2 106 h.p., ube	2 150 h.p., Browett-Lindley comp. cond. direct coup.; 250 revs., 2 150 h.p., do., belted	4 100 kw. Westinghouse, 1 17 kw.	417	—	—	—	£126,000	Dec., 1895 July, 1899	T. R. Whitehead (Mngr. & Res. Engr.)	J. E. Winslow	—	—	—	
30 ft. by 8 ft., estructor	Belliss-Morcom, 2 250 h.p., 1 450 h.p.	Siemens, 2 150 kw. comp. 1 300 kw. shunt	600	£41,500	—	£15,000	£56,500 *	Oct., 1900	Stanley Clegg	Stanley Clegg †	—	—	—	Energy from lighting s † With R. W. Smith-S
Wilcox	Browett-Lindley	E.C.C.	—	—	—	—	—	—	J. W. Endean (Traff. Supt)	F. S. Pilling	—	—	—	Power from Devonport to open in December
be	2 McIntosh - Seymour horiz. tand. compd.	2 G.E., 6-pole compound	200	£16,944 (with bndg.)	*	£13,311	£37,350	Sept., 1897	E. Carden ..	H. E. Stilgoe	242,434 c.m. 2,437,863 p.	5·51	85 %	Tudor storage battery. Co., Ltd.
k-Wilcox, me- l stokers and iser	6 Allis, 750 h.p., vertical tandem compound condensing	6 B.T.H., 500 kw., multipolar compound	3,000	—	—	—	—	1896	C. W. Gordon	J. W. Towle. H. F. Parshall (Consulting)	—	5·24	64 %	Power transmitted to system at 2,500 volts
ire.....	2 Ball-Wood compound horiz. condensing	Two Walker	120	£10,000	£2,729	£19,485	£32,214	March, 1900.	S. C. Cashel	S. C. Cashel	103,808 c.m., 602,012 p.	—	—	Formerly worked by st
8 ft. by 7 ft...	3 175 i.h.p. Ball-Wood horizontal tandem compound	3 100 kw. British Thomson-Houston	300	—	—	—	—	Oct., 1900	R. Smith ..	R. N. Tweedy	387,000 c.m., 2,565,000 p.	—	—	Line within Borough o stn. Now construct 4½ miles., 5¼ miles r
.....	Westinghouse	Westinghouse	*	—	—	—	—	Oct., 1900	Frank Hatch	—	—	—	—	* Power from Dudley
30 ft. by 8 ft., by 7 ft.	10 Willans	Parker and Siemens ..	1,288	£31,241	£41,810 *	£16,980 †	£91,791 †	July, 1900	P. Fisher ..	W. H. Tittensor	—	—	—	Extensions in progress * Power supplied from † Exclusive of cables
be	4 compound horizontal direct coupled	4 Dick-Kerr, 3 225 kw., 1 100 kw.	825	—	—	—	—	—	W. C. Ullmann	W. C. Ullmann	—	—	—	Tramway and power h
—	2 turbines, 75 and 40 h.p.	2 E.C.C.	—	—	—	—	£54,572	Mar., 1883	Daniel Fall..	W. A. Traill	17,875 c m., 99,500 p.	3½d.	—	Traffic partly worked months
-Wilcox	3 McIntosh - Seymour tandem compound 200 revs. per minute	3 Westinghouse, 200 kw., 8 poles	600 (5 miles)	£55,000 (5 miles)	Gr'nd, bdgs. and plant, £24,960 (5 miles)	£62,378 (5 miles)	£142,338	Oct. '98 Jan. '99 Nov. '99	John Young	W. Clark, Chf. Engineer; M. B. Field, Chf. El. Engr	927,870 c.m. (5 miles), 14,825,858 p *	6·26	45 %	35 miles double track to be constructed. * 1¾ miles of this c months.
x - Wilcox, 2	2 compound condensing	Siemens, compound, belt driven	100	—	—	—	£33,628	Feb., 1892	A. L. Davis	A. L. Davis	141,834	6·45	64 %	
water tube	Low speed horiz. and high speed, Belliss	E. C. C., with battery..	1,250	£40,000	£73,000	£24,000	£137,000	June, 1898	F. Spencer..	H. F. Street	551,105 c.m. 7,308,998 p.	10·15	76·5 %	24 miles new track un Interest and sinking fu
, 20 ft. by 6 ft., shire	3 Willans vertical compound	2 E.C.C., 1 Mather-Platt	240	—	—	—	£33,137	May, '96 Feb., '99	A. R. Secker (Traffic Supt.)	H. W. Pinkerton (Pow. Supt.)	292,552 c.m. 2,423,083 p	8·08	71·25 %	Lines worked and exte Tramways Co., Ltd.
0 ft. by 8 ft...	3 Belliss tandem compound	3 Siemens, 2-pole compound, direct coupled	900	£38,443	£24,218 (depots, £6,883)	£17,700	£87,344 *	July, 1899	W. J. McCombe	A. S. Barnard	573,420 c.m. 6,218,971 p.	4·47	40·6 %	Last three columns r double track then ru * Capital outlay figur
0 ft. by 6 ft., way, 26 ft. by s.	5 Galloway vert. comp., 90 h.p., 3 Robb-Armstrong hor. tand. com., 180 h.p., 2 Vict. turb.	5 Mather-Platt, 50 kw., 3 E.C.C., 120 kw., 2 E C C., 83 and 32 kw.	250 and 475	—	—	—	—	July, '94 and Aug., '98	J. Shaw	J. Shaw	—	—	—	2 accumulator sub-stat
26 ft. by 6 ft.	5 Mather-Platt horiz. comp., 120 h.p.	5 Mather-Platt, 60 kw. each	300	—	—	—	—	Aug., 1895	J. Shaw	J. Shaw	—	—	—	1 accumulator sub-sta
.....	2 Browett-Lindley	Westinghouse, 6 polar, belt driven	200	—	—	—	£36,676	Aug., 1896	—	—	—	—	—	
—	—	2 B.T.H., 800 kw.; 3-ph. 2,500 v., 2 200 kw. dir. cur., 500 v., 6 rot. con.	—	—	—	—	—	—	—	—	—	—	—	Works now in active early in 1901.
								May	A. Stewart	J. B. Clarke	152,173 c m.	5·32	63·19	

"Review" List of Electric Tramways and R

OVERHEAD TROLLEY

Track.	Gauge.	Weight of Rails per yard.	Character of Overhead Work.	Number of Motor Cars.	Number of Trailers	Car Motors.	POWER STATION EQUIPMENT. Boilers.	Engines.	Generators.	Total capacity in KW.	CAPITAL OUTLAY. Permanent Way.	Power Station.	Rolling Stock and Electrical Equipments.	Total.
	ft. in.													
miles double, mile single	4 8½	98 lbs.	1½ miles centre pole, 1½ miles span wire	12	—	2 30 h.p. Westinghouse	8 Babcock-Wilcox	Willans and Belliss ..	1 Bruce-Peebles, 200 kw.; 2 Holmes, 110 kw.	420	£20,330	*	£19,731	£40,061
t 1½ miles..	4 8½	90 lbs.	Side pole	5	4	—	Babcock-Wilcox	W. H. Allen	Thames Ironworks	200	—	—	—	—
es	4 0	92½ lbs.	Bracket arms, centre and side poles	8	—	Siemens, two per car	Lancashire.....	Willans and Belliss....	Siemens, Mather and Platt, and E.C.C.	*	—	*	—	£155,283
iles double: mile single: miles double hand	4 8½	96 lbs. and 95 lbs.	Bracket arms, with side and centre poles	26, extensions 15	—	2 G.E 52	—	2 Parsons steam turbines, 2 do. in hand	2 Parsons ..... 2 do in hand	250 400	—	—	Cost of conversion £11,000	—
enclosed for h speed, 2 m. mway	4 8½	98 lbs., 88 lbs., 86 lbs.	Bracket arm, centre and side poles, and span wire	30	3	2 G.E. 1000 (bogie trucks)	4 Lanc., 30 ft. by 8 ft.. and economiser	5 Mather-Platt dir. cpld. vertical compound, 200 h.p., 165 r. p. m.	5 Mather-Platt, 6-pole shunt, 120 kw.	600	£110,170	£60,915 *	£23,824	£194,909
iles single (14 es new)	4 8½	100 lbs.	Mainly side brackets, span wire	70	—	Dick-Kerr and B.T.H.	—	2 1,000 h.p., 2 500 h.p., Musgrave vertical compound	2 600 kw., 2 300 kw., Mather-Platt 12-pole compound	1,600	£120,000 (about)	£40,000 (about)	£85,325 *	—
iles	4 0	Girder 105 lbs., Dem'rbe 70½	Bracket arm suspension	53	—	Westinghouse, No. 49, and Dulait (Belgian)	12, of 5,720 h.p., Lancs. and marine, 1 water-tube	15, of 5,230 h.p., chiefly Willans	15 Siemens	3,189	£62,608	—	£37,737	—
es, 2 tracks d as one, ft. over all	Each track 2 8½	55 lbs.	Steel and wood poles, bridle suspension	1	—	4 G.E., 25 h.p.	—	—	—	60	—	—	—	£35,792
iles	4 8½	92½ lbs.	Side and centre poles, and span wire	51	15	2 G.E. 800 and 52	4 Lanc., mechanical stokers	4 250 h.p., McIntosh-Seymour, direct coup., 200 revs. p. m.	4 G.E., 150 kw..... Negative boosters	600	—	—	—	—
iles double. miles single	4 8½	100 lbs.	Centre poles chiefly, side bracket, and some span wire	120	—	2 30 h.p. per car	4 Lanc., 30 ft. by 8 ft., Musgrave	4 Musgrave vertical com. Corliss cond., 500 h.p., 100 revs. per min.	4 Westinghouse, 300 kw., direct on shaft	1,200	—	—	—	—
les	3 6	86 lbs.	Bracket arm	12	—	2 25 h.p., Dick-Kerr	—	—	—	—	—	—	—	£100,000
les double, miles single	3 0	86 lbs	Chiefly centre pole, with bracket arms	28	—	2 B.T.H , 27 h.p.	6 Babcock-Wilcox	3 McIntosh-Seymour, 2 Allis, horiz. tandem compound condg.	B.T.H., 6-pole comp., direct coupled	1,400 *	—	*	—	—
, single and single, Falk s, steel slprs	3 6	84 lbs. and 65 lbs.	Cross suspension and side brackets	20	5	Each car 2 20 h.p., Westinghouse	2 172 h.p., 2 106 h.p., water tube	2 150 h.p., Browett-Lindley comp. cond. direct coup.; 250 revs., 2 150 h.p., do., belted	4 100 kw. Westinghouse, 1 17 kw.	417	—	—	—	£126,000
miles double	4 0	95 lbs.	Span wire, rosettes and side poles	10 (bogie)	—	G.E. 52, West. 49 and 46	3 Lanc., 30 ft. by 8 ft., refuse destructor	Belliss-Morcom, 2 250 h.p., 1 450 h.p.	Siemens, 2 150 kw. comp. 1 300 kw. shunt	600	£41,500	—	£15,000	£56,500 *
iles, mostly ible	3 6	92½ lbs.	Side trolley and centre pole	20	—	G. E. 58	Babcock-Wilcox	Browett-Lindley	E.C.C.	—	—	—	—	—
les single, miles double	3 6	87 lbs.	Side poles with bracket arms	16	—	2 G.E. 800, Walker 33S	2 water tube	2 McIntosh - Seymour horiz. tand. compd.	2 G.E., 6-pole compound	200	£16,944 (with bndg.)	*	£13,311	£37,350
les double..	5 3	92 lbs.	Centre pole, span wire, and side bracket	300	—	G.E. 52 and 800, Dick-Kerr, 30 h.p.	12 Babcock-Wilcox, mechanical stokers and economiser	6 Allis, 750 h.p., vertical tandem compound condensing	6 B.T.H., 500 kw., multipolar compound	3,000	—	—	—	—
miles single, mile double	3 6	50 lbs.	Side bracket	5	4	20 h p., Walker, type N.	2 Lancashire.....	2 Ball-Wood compound horiz. condensing	Two Walker	120	£10,000	£2,729	£19,485	£32,214
iles	3 6	87 lbs.	Span wire, centre pole, side brackets	44	—	2 G.E. 800, and Dick-Kerr	3 Lanc., 28 ft. by 7 ft...	3 175 i.h.p. Ball-Wood horizontal tandem compound	3 100 kw. British Thomson-Houston	300	—	—	—	—
miles single h loops	3 6	—	Bckt. arm, side trol., some span wire	13	—	G.E. 800 and Dick-Kerr	Babcock.....	Westinghouse	Westinghouse	*	—	—	—	—
iles double, mile single	4 8½	92 lbs. and 95 lbs.	Side and centre poles, with bracket arm and span wire, side trolley	20	—	Dick-Kerr	Lanc., 4 30 ft. by 8 ft.; 4 24 ft. by 7 ft.	10 Willans	Parker and Siemens ..	1,285	£31,241	£41,810 *	£16,980 †	£91,791 †
iles double, miles single	4 8½	87 lbs.	Side poles, with bracket arms	10	—	Dick-Kerr	4 water tube	4 compound horizontal direct coupled	4 Dick-Kerr, 3 225 kw., 1 100 kw.	825	—	—	—	—
es single ..	3 0	43 lbs.	Overhead trolley ..	4	4	T.H., 2 per car and Siemens, 1 per car	—	2 turbines, 75 and 40 h.p.	2 E.C.C.	—	—	—	—	£54,672
ing, 5 miles ible	4 7¾	100 lbs.	Span wire	47	—	General Electric and Westinghouse	3 Babcock-Wilcox	3 McIntosh - Seymour tandem compound 200 revs. per minute	3 Westinghouse, 200 kw., 8 poles	600 (5 miles)	£55,000 (5 miles)	Gr'nd, bdgs. and plant, £24,960 (5 miles)	£62,378 (5 miles)	£142,338
es single ..	4	40, 74, 82 lbs.	Bracket suspension	8	7	Siemens, and G.E. 800	1 Babcock - Wilcox, 2 loco.	2 compound condensing	Siemens, compound, belt driven	100	—	—	—	£33,628
iles	3	98 lbs.	Side poles and span wire	40	—	E.C.C., West., B. T. H.	Lanc. and water tube	Low speed horiz. and high speed, Belliss	E. C. C., with battery..	1,250	£40,000	£73,000	£24,000	£137,000
iles single ..	3 6	65 lbs. & 87 lbs.	Side trolley (Dickinson)	15	—	2 15 h p. Walker, 2 E.C.C.	2 Galloway, 20 ft. by 6 ft., 1 Lancashire	3 Willans vertical compound	2 E.C.C., 1 Mather-Platt	240	—	—	—	£33,137
les double, 1 le single, cen- groove rails	4 8½	96 lbs.	Bracket arm, centre and side poles, and span wire	66	—	Westinghouse, Siemens and G.E. 52	4 Lanc., 30 ft. by 8 ft..	3 Belliss tandem compound	3 Siemens, 2-pole compound, direct coupled	900	£38,443	£24,218 (depots, £6,868)	£17,700	£87,244 *
miles double	3 0	56 bs. and 62½ lbs.	Bracket arm, centre pole	22 1 Loco	22 12 goods wagns	2 20 h.p. per car, 4 20 h.p. per car	5 Lanc., 20 ft. by 6 ft., 3 Galloway, 26 ft. by 6 ft. 6 ins.	5 Galloway vert. comp., 90 h.p., 3 Robb-Armstrong hor. tand. com., 180 h.p., 2 Vict. turb.	5 Mather-Platt, 50 kw., 3 E.C.C., 120 kw., 2 E.C.C., 69 and 32 kw.	250 and 475	—	—	—	—
iles double ..	3 6	56 lbs. 65 lbs. (cntr. rl.)	Do.	6	—	4 25 h.p. per car	4 Lanc., 26 ft. by 6 ft. 6 ins.	5 Mather-Platt horiz. comp., 120 h.p.	5 Mather-Platt, 60 kw. each	300	—	—	—	—
iles	4 6½	—	Side trolley, bracket arms	8	8	2 25 h.p., G.E. 800	2 Babcock	2 Browett-Lindley	Westinghouse, 6 polar, belt driven	200	—	—	—	£36,676
miles	3 6	—	—	—	—	B.T.H.	—	—	2 B.T.H., 800 kw.; 3-ph. 2,500 v., 2 200 kw. dir.	—	—	—	—	—

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nd Railways in the United Kingdom.

EY LINES.

OUTLAY. Rolling Stock and Electrical Equipments.	OUTLAY. Total.	Date opened.	Tramways Manager.	Electrical Engineer.	Annual Car Mileage, and Passengers Carried.	Cost per Car Mile, Pence.	Ratio of Expenses to Receipts.	REMARKS.	LOCALITY.
£19,731	£40,061	Dec., 1899	D. Moonie..	J. Alex. Bell	—	6·39	—	£150,000 extension sanctioned, and equipment of new section in progress. * Lighting plant used—no capital charged to tramway	**Aberdeen**.....(1)
—	—	—	—	S. E. Britton	—	—	—	Consulting Engineer, W. C. C. Hawtayne. Contracts placed ..	**Barking Town and Beckton** ....(2)
—	£155,283	March, 1899	A. S. Giles ..	A. S. Giles..	169,942 c.m., 2,079,633 p.	6·82	56 %	Corporation now equipping 15 miles of existing track. 60 bogie motor cars, each with 4 motors (40 B.T H., 20 Dick-Kerr), and to carry 66 pass., on order. * Cmbd. lghtg. and trctn. station.	**Blackburn** .....(3)
Cost of onversion £11,000	—	Converted June, 1899	J. Lancaster	R. C. Quin..	318,885 c.m., 3,421,736 p.	—	—	Combined lighting and traction station. Converted to overhead trolley system June, 1899, formerly conduit system. General expenses, March, 1900, = £15,145, receipts = £22,611. Storage battery, Hart Accum. Co., 260 cells, 436 kw.	**Blackpool** .....(4)
£23,824	£194,909	July, 1898	J. Cameron (and Sec.)	J. McMahon	516,354 c.m., 1,821,792 p	5·18	56·78 %	Two chloride batteries in sub-stations, 360 ampere hours each .. * Including overhead wires, poles, cables, and buildings.	**Blackpool and Fleetwood** .....(5)
£85,325 *	—	Jan., 1900	A. A. Day (Engineer)	—	6 months. 683,113 c.m., 8,575,140 p.	6·05	—	Combined lighting and traction station ..... * Cars, £34,825; overhead work, £26,000; bonding £6,500; feeders, £18,000. Lease, £55,000; car shed and offices, £50,000.	**Bolton** .....(6)
£37,737	—	July, 1898	C. J. Spencer	R. A. Chattock	391,644 c. m.	9·8	79·6 %	6 lines running. Several lines projected but not yet sanctioned. Combined lighting and traction station.	**Bradford** .....(7)
—	£35,792	Nov., 1896	M. Volk	M. Volk	5,756 c.m., 100,081 p.	—	70·3 %	60 kw. G.E. direct current transformer taking town supply, transforming from 230 to 550 volts.; Tudor battery.	**Brighton and Rottingdean** ....(8)
—	—	Oct., 1895	Samuel White (Managing Director)	J.C.Robinson, H. F. Parshall (consg.)	—	—	—	40 miles, changing to electricity. 250 cars. New central power station now erecting (10-pole direct current generators).	**Bristol** .....(9)
—	—	—	Arthur	Ellis	—	—	—	To open January 1st, 1902	**Cardiff**.....(10)
—	£100,000	June, 1900	G. Cook (and Secretary	—	* 73,389 c. m. * 833,408 p.	—	—	Energy suppld. by Corptn. Engineers, Pritchard & Co., A. Dickinson & Co. * June 30th to Nov. 3rd, 1900; energy used 71,637 B.T.U.	**Carlisle** .....(11)
—	—	Dec., 1898	W. G. Davies	C. H. Merz (and Sec.)	About 750,000 c. m., 5,500,000 p	—	—	Tudor storage battery, 800 amperes for 2 hours. * Combined lighting and traction station.	**Cork**.....(12)
—	£126,000	Dec., 1895 July, 1899	T. R. Whitehead (Mngr. & Res. Engr.)	J. E. Winslow	—	—	—	———	**Coventry** .....(13)
15,000	£56,500 *	Oct., 1900	Stanley Clegg	Stanley Clegg †	—	—	—	Energy from lighting station. * Exclusive of power station .... † With R. W. Smith-Saville.	**Darwen** .....(14)
—	—	—	J. W. Endean (Traff. Supt)	F. S. Pilling	—	—	—	Power from Devonport Corporation Electricity Works. Expected to open in December, 1900.	**Devonport and Suburbs**.....(15)
13,311	£37,350	Sept., 1897	E. Carden ..	H. E. Stilgoe	242,434 c.m. 2,437,863 p.	5·51	85 %	Tudor storage battery. * Energy from Dover Electricity Supply Co., Ltd.	**Dover** .....(16)
—	—	1896	C. W. Gordon	J. W. Towle. H. F. Parshall (Consulting)	—	5·24	64 %	Power transmitted to sub-station at Blackrock by 3-phase system at 2,500 volts.	**Dublin and District** .....(17)
19,485	£32,214	March, 1900.	S. C. Cashel	S. C. Cashel	103,808 c.m., 602,012 p.	—	—	Formerly worked by steam	**Dublin and Lucan** .....(18)
—	—	Oct., 1900	R. Smith ..	R.N. Tweedy	387,000 c.m., 2,565,000 p.	—	—	Line within Borough of Dudley supplied with power from Corptn. stn. Now constructing: Dudley and district 8½ miles; Kinver, 4½ miles. 5½ miles now ready for running.	**Dudley, Stourbridge, and District** (19)
—	—	Oct., 1900	Frank Hatch	—	—	—	—	* Power from Dudley Corporation Electricity Works	**Dudley and Wolverhampton** ..(20)
16,980 †	£91,791 †	July, 1900	P. Fisher ..	W. H. Tittensor	—	—	—	Extensions in progress. 1 600 kw. Willans-Parker set on order. * Power supplied from lighting station. † Exclusive of cables.	**Dundee** .....(21)
—	—	—	W. C. Ullmann	W. C. Ullmann	—	—	—	Tramway and power house now under construction	**East Ham** .....(22)
—	£54,872	Mar., 1883	Daniel Fall..	W. A. Traill	17,875 c m., 99,500 p.	3½d.	—	Traffic partly worked by steam in addition during the summer months	**Giant's Causeway and Portrush** (23)
2,378 miles)	£142,338	Oct. '98 Jan. '99 Nov.'99	John Young	W. Clark, Chf. Engineer; M. B. Field, Chf. El. Engr	927,870 c.m. (5 miles), 14,825,858 p.	6·26	45 %	35 miles double track being equipped; 19 miles new double track to be constructed. * 1½ miles of this only open for traffic during the latter six months.	**Glasgow**.....(24)
—	£33,628	Feb., 1892	A. L. Davis	A. L. Davis	* 141,894	6·45	64 %	———	**Guernsey** .....(25)
4,000	£137,000	June, 1898	F. Spencer..	H. F. Street	551,105 c.m., 7,308,998 p.	10·15	76·5 %	24 miles new track under construction. 1,500 kw. plant on order. Interest and sinking fund, 1·76d. Profit, 1·36d. per car mile.	**Halifax** .....(26)
—	£33,137	May, '96 Feb., '99	A. R. Secker (Traffic Supt.)	H. W. Pinkerton (Pow. Supt.)	292,552 c.m., 2,423,083 p.	8·08	71·25 %	Lines worked and extensions (2½ miles) owned by Hartlepool El. Tramways Co., Ltd. E.P.S. battery for lighting and power.	**Hartlepool** .....(27)
7,700	£87,244 *	July, 1899	W. J. McCombe	A. S. Barnard	573,420 c.m., 6,218,971 p.	4·47	40·6 %	Last three columns refer to nine months' working of 3½ miles double track then running. * Capital outlay figures are to September 30th, 1899.	**Hull** .....(28)
—	—	July, '94 and Aug., '98	J. Shaw	J. Shaw	—	—	—	2 accumulator sub-stations, 250 and 260 chloride cells	**Isle of Man**—(1) Douglas, Laxey and Ramsey .....(29)
—	—	Aug., 1895	J. Shaw	J. Shaw	—	—	—	1 accumulator sub-station, 250 chloride cells	(2) Snaefell Mountain .....(30)
—	£36,676	Aug., 1896	—	—	—	—	—	———	(3) Douglas Southern .....(31)
—	—	—	—	—	—	—	—	Works now in active construction. Line to be opened for traffic early in 1901.	**Isle of Thanet** (Margate and Ramsgate) .....(32)
								———	**Kidderminster and Stourport** (33)

by 8 ft., t. | 10 Willans ..... | Parker and Siemens .. | 1,280 | £31,241 | £41,810 * | £16,980 † | £91,791 † | July, 1900 | F. Fisher .. | W. H. Tittensor | — | — | — | Extensions in progress. * Power supplied from lighting station.

Thornaby	ways Co., Ltd.	(route 9 miles)			poles, bracket arm			(bogie trucks)	weighing hoppers and economiser
(40) **Newcastle-on-Tyne**	Corporation	11½ miles existing (20¼ mls. projected)	4	8½	101 lbs.	Centre poles with brackets, side poles with span wires	135	—	G.E. 58	Lancashire.....
(41) **Norwich**	Norwich Electric Tramways Co.	13 miles single, 3 miles double	3	6	65 lbs.	Bracket arm and span wire	40	10	2 Westinghouse, No. 46A	Babcock-Wilcox, 4 300 h.p.
(42) **Nottingham**	Corporation	14¼ m. dbl., 4 m. sgl.	4	8½	100 lbs.	——	—	—	Dick-Kerr	——
(43) **Oldham**	Corporation	25 miles	4	8½	100 lbs.	Bracket arms and centre poles	150	—	Dick-Kerr	——
(44) **Oldham, Ashton, and Hyde** ..	Oldham, Ashton, and Hyde Electric Tram. Co.	8 miles	4	8½	90 lbs.	Span wire	30	8 (on order)	2 G.E. 50	Lancashire .....
(45) **Plymouth**	Corporation	3·1 miles single; 2·7 miles now being equipped	3	6	92 lbs.	Side brackets chiefly, span wires and centre poles	20	—	Westinghouse, 2 25 h.p.	7 Lanc., 30 ft. by 7 ft. 6 ins.
(46) **Portsmouth**	Corporation (after 1st Jan., 1901)	6¾ miles double, 4 miles single	4	7¾	96 lbs.	Side bracket and span wire	80	—	2 25 h.p. Dick-Kerr	3 Babcock-Wilcox, and economiser
(47) **Potteries (North Staffordshire)**	Potteries Electric Trac. Co., Ltd.	33 miles	4	0	87½ lbs.	Span wire and bracket arms	68 single truck	—	G.E. 800, and 58	(A) 4 Lancs., 30 ft. by 7 ft., economiser
							20 bogie truck	—	Walker, 33N ..	(B) 3 30 ft. by 8 ft Lancs., economiser
(48) **St. Helens, Lancashire**	Corporation	15 miles running	4	8½	90 lbs.	Span wire and side brackets, centre trolley	36	—	2 G.E. 52	4 Lancs., 2 Babcock-Wilcox (destructor), suprhtrs. and econmsrs.
(49) **Salford**	Corporation	35 miles single ..	4	8½	103 lbs.	Centre poles chiefly, and span wires	150	—	——	16 Lancashire, 30 ft. by 9 ft.
(50) **Sheffield**	Corporation	2 miles single, 9 miles double	4	8½	108½ lbs.	Centre and side poles, bracket arm, and span wires	220	—	G.E. 52	7 marine, Brown & Co., Ellis-Eaves induced draught
(51) **Southampton**	Corporation	7 miles single ..	4	8½	86 lbs.	Side and centre poles	20	8	Westinghouse	Babcock-Wilcox .....
(52) **Southend-on-Sea**	Corporation	7½ miles	3	6	91 lbs.	Bracket arm	14	—	B.T.H.	3 .....
(53) **Southport**	Corporation	3⅜ miles single, 1 mile double	4	8½	87 lbs.	Side poles, bracket arms	15	—	2 25 h.p. Dick-Kerr	Lancashire * .....
(54) **South Staffordshire**	South Staffordshire Tram. Co.	8 miles	3	6	—	Side trolley	16	—	2 15 h.p., E.C.C.	3 Lanc., 30 ft. by 7 ft. ..
(55) **Sunderland**	Corporation	13·5 miles single	4	8½	96 lbs.	Span wire and bracket arm, with side and centre poles	50	—	Dick-Kerr, 2 25 h.p. per car	4 Galloway, 28 ft. by 8 ft. 6 in., economiser
(56) **Swansea**	Swansea Improvements & Tr. Co.	5½ miles; 3 miles single, 2½ double	4	8½	86 lbs.	Bracket arm and span wire	41	—	2 25 h p. West-'house, Brush and B.T.H.	2 Babcock-Wilcox ....

ELE

LONDON.

(1) **Baker Street and Waterloo Electric Railway.**—Underground tunnels; contractors for line construction, Messrs. Perry & Co.; length 3 miles 1 furlong. To connect Baker Street with Waterloo Station. Stations to provide connection with the Metropolitan District Railway at Charing Cross and Metropolitan Railway at Baker Street, and with the Central London Electric Railway at Oxford Circus, and with the Great Central at Marylebone Terminus. Shafts sunk by side of S.E.R. bridge at Charing Cross. Work has been proceeding for about 1¾ years, but another two years will elapse before completion. Engineers, Sir Benjamin Baker, Messrs. Galbraith & R. Church.

(2) **Central London Railway.** — Underground; separate tunnels for "up" and "down" roads; 13 miles track, Shepherd's Bush to Bank; gauge of track, 4 ft. 8½ in.; rails, 100 lbs.; system of working, high tension with 4 transformer substations; working current, 500 volts; 32 locomotives; 170 carriages (7 per train). Power station (Shepherd's Bush) equipment:—16 Babcock-Wilcox water tube boilers, 6 Reynolds-Corliss horizontal compound condensing engines, 6 B.T.H. three-phase alternators (5,000 volts); total capacity, 5,160 kw. General manager, G. C. Cuningham. Opened for traffic 30th July, 1900. Run, 3-minute service; 9 trains, 6 carriages per train. Passengers carried, 2,750,000 per month.

(3) **City and South London Electric Railway.**—Moorgate Street to Clapham Common.—Twin tunnels, 4¾ miles. Gauge of track, 4 ft. 8½ in.; weight of rails, 60 lbs. and 80 lbs. per yard; 32 electric locomotives. Annual car mileage, 468,500. The new power station contains 9 Economic boilers, 15 ft. by 8 ft. 9 in., 2 horizontal Corliss engines of 1,100 h.p. each and 2 250 h.p. Willans direct E.C.C. multipolar generators; t 2,800 kw. Manager, T. C. Jenki engineer, P. V. McMahon.

(4) **Great Northern & City Electric** Finsbury Park to Moorgate St ground tunnels. Messrs. Pearson & contractors for the construction a Electric locomotives. Engineers, Fox and Mr. Francis Fox. Genera Regent's Canal. Date of com 1902.

(5) **Waterloo and City Electric** Twin C.I. tunnels; gauge, 4 ft. 8½ lbs.; 500 volts direct current; thir running rails; 17 motor cars; 10 tr station equipment:—Paxman Eco

AMBROIN

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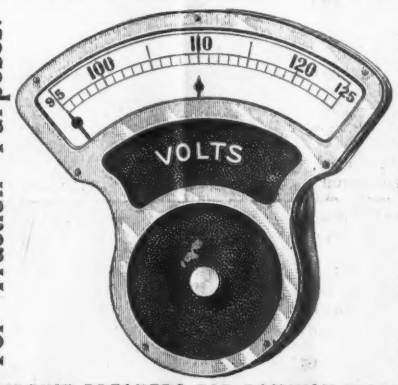

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weighing hoppers and economiser	Corliss hor. com. condensing, 94 r.p.m.	pole, 2,500 v., 8-phase alter., 25 ~ per sec.						1898	son, Man. Director		8,307,322 p.			
ancashire.....	Vertical comp., marine type	Multipolar, direct coup.	2,600	—	—	—	—	—	A. E. Le	Rossignol	—	—	—	Work in progre
abcock-Wilcox, 4 300 h.p.	4 300 h.p. Browett-Lindley comp. cond.	4 Westinghouse direct coupled. 200 kw.	800	—	—	—	—	July, 1900	A. N. Banister	A. N. Banister	—	—	—	
—	—	—	—	—	—	—	—	—	J. Aldworth	H. Talbot ..	—	—	—	Arrangements u
—	—	—	—	£163,000	—	£150,401	£322,401	Dec., '00	—	—	—	—	—	Work in progre
ancashire	Browett-Lindley	P. R. Jackson	—	—	—	—	—	June, 1899	E. H. Mottram (Supntdt.)	J. A. Fraser (Power (Supntdt.)	293,885 c m. 2,021,871 p.	6 0	59·34	Energy obtaine
Lanc., 30 ft. by 7 ft. 6 ins.	2 Belliss, 150 h.p., 375 revs. p. m.; 1 Belliss, 700 h.p., 330 revs. p. m.	2 Westinghouse, 6-pole, 100 kw.; 1 do. 8-pole, 500 kw.	700	—	£120,000 including work in prog. *	£20,200	—	Sept., 1899	C. R. Everson	J. H. Rider	Est. 400,000 c.m.; abt. 4,000,000 p.	—	—	Tudor battery, ampere hours * Combined
Babcock-Wilcox, and economiser	2 comp, Corliss, 640 h p 1 do. do. 320 h.p.	2 400 kw., 1 200 kw., multipolar, Dick-Kerr	1,000	—	£40,171 *	£48,562 *	£88,733 *	—	E. Rotter	E. Rotter	—	—	—	* Amounts of c
) 4 Lancs., 30 ft. by 7 ft., economiser	(A) 2 McIntosh-Seymour, 2 Ball-Wood, 330 h.p., 1 Universal, 45 h.p.	(A) 4 G.E., 220 kw, 6 pole, 1 80 kw., 1 40 kw.	950	—	—	—	—	May, 1899	W. Slade (Managing	Olver Engineer)	—	—	—	Capital issued
) 3 30 ft. by 8 ft Lancs., economiser	(B) 2 350 h.p. vert. Browett-Lindley, 1 Alley-McLellan 35 h.p. com.	(B) 2 250 kw, 4 pole Bruce-Peebles, 1 30 kw.	530	—	-	—	—	—	—	—	—	—	—	(B) Maybank p
Lancs., 2 Babcock-Wilcox (destructor), suprhtrs. and econmsrs.	5 Willans, 1 500 h.p., 2 360 h.p., 2 200 h.p.	4 Mather-Platt, 4-pole; 1 Dick-Kerr multipolar	980	—	£51,500 *	—	—	July, 1899	J. F. Cutler	J. S. Highfield	600,000 c.m. 4,000,000 p.	—	—	Comb. ltg. and New St. Hele 3 chloride bat
Lancashire, 30 ft. by 9 ft.	8 Browett-Lindley comp vert., 100 r.p.m., 1,600 h.p.	8 compound, 800 kw. direct coupled	6,400	—	—	—	—	—	E. Hatton (Engineer)	F. A. Wilkinson (*pro tem.*)	—	—	—	Lines constructi
marine, Brown & Co., Ellis-Eaves induced draught	3 Allis hor. tand. compd. cond., 350 h.p. each 2 Cole, Mrchnt. & Morley vertical compound	3 G.E. 225 kw. each, 2 G.E. 500 kw.	1,675	—	—	—	—	Sept., 1899	A. L. C. Fell	A. L. C. Fell	—	—	—	Lines running, Lines constructi Lines planned, 3
bcock-Wilcox	Willans	Crompton	430	—	£10,000	—	—	Jan. 1900	G. B. Carnon	F. H. Chaplin	600,000 c. m.	—	—	Lighting plant
.....	3	3	500	—	—	—	£90,926	—	—	—	—	—	—	To be opened M
ncashire *	2 Belliss, 330 i.h.p., 350 r.p.m.	2 Bruce-Peebles, 200 kw.	400	£11,149, rails only	£6,575 †	£14,245	£72,575 (estimated)	July, 1900	R. J. Wilson	C. D. Taite..	72,946 c.m. to date. 638,539 p.	—	—	Receipts per ca station. † Co
Lanc., 30 ft. by 7 ft. ..	3 Musgrave, horizontal compd. cond., 125 h.p.	3 E.C.C., 90 kw. each, rope driven	270	—	—	—	—	Jan., 1898	J. J. Robins	J. J. Robins	257,312	—	—	Leased to South
Galloway, 28 ft. by ft. 6 in., economiser	3 Belliss, enclosed direct coupled, 420 h.p. each, 400 rev. p.m.	3 Sunderland Forge 4-pole compound, 270 kw.	810	£96,000 (13·5 miles only)	£32,000	Approx. £30,000 (13·5 miles)	£158,000	Aug. 1900	W. Morrison	J. F. C. Snell	50,000 c.m. 984,344 p. *	—	—	Power supplied track in all to * For three mo
Babcock-Wilcox	2 Ball-Wood horizontal direct coupled	2 Westinghouse multipolar compound	400	—	—	—	—	June, 1900	D. James ..	E. S. Rayner	—	5·03	42 %	

ELECTRIC RAILWAYS.

nes of 1,100 h.p. each, 2 500 h.p., h.p. Willans direct coupled to ltipolar generators; total capacity, Manager, T. C. Jenkins. Electrical V. McMahon.

hern & City Electric Railway.—ARK TO MOORGATE STREET.—Underels. Messrs. Pearson & Son, Limited, for the construction and equipment. omotives. Engineers, Sir Douglas Francis Fox. Generating station on anal. Date of completion, June,

and City Electric Railway.—nnels; gauge, 4 ft. 8½ in.; rails, 87½ lts direct current; third rail between ; 17 motor cars; 10 trailers. Power pment:—Paxman Economic boilers,

Belliss enclosed compound engines, Siemens generators; total capacity, 1,200 kw. Total capital outlay (to June 30, 1900), £589,073. Line opened August, 1898. Manager, C. J. Owens. Electrical engineer, D. Heap. Annual mileage, about 120,000 train miles per annum.

PROVINCIAL.

(6) **Bessbrook and Newry Tramway.**—Three miles double track; gauge, 3 ft.; rails, 41¼ lbs. Operated on third-rail system. Two motor cars; 26 trailers; 1 Mather-Platt 20 h.p. motor per car; chain gear (each motor car hauls 4 trailers). Power station equipped with 1 62 h.p. turbine at 290 revolutions per minute, driving by belt 2 Mather-Platt generators of 18 kw. each, at 1,000 revolutions per minute. Total capital issued, £15,000. Date of opening, October, 1885. Manager, J. Dawson. Engineer, J. L. D. Mears.

(7) **Brighton.**—VOLK'S ELECTRIC RAILWAY.—Third-rail system; 1 mile track (single) with turn-outs; gauge, 2 ft. 8½ in.; 35 lb. flat bottom rails. Five motor cars: 1 trailer; 1 motor to each car. Electrical equipment:—15 kw. Parker direct current transformer takes current at 230 volts, transformed down to 160 volts; 80 Tudor cells, H. A. 7, 120 ampere hours. Owner and manager of system, Magnus Volk.

(8) **Herne Bay Pier Electric Railway.**—Owned by the Herne Bay Pier Company, Ltd. ¾ mile; gauge, 3 ft.; third rail (angle bar beneath deck); one car; installation by B.T H. Co., driven by an 83 b.h.p. Stockport gas engine. Engineer, H. C. Dufton.

(9) **Liverpool Overhead Electric Railway.**—6½ miles double; gauge, 4 ft. 8½ in.; rails, 62 lbs. Third-rail system; 46 motor cars, 8 trailers, 48 car motors. Power statio 6 boilers, 7 engines, and kw. capacity. Date open Manager and electrical eng Annual train mileage, carried, 9,902,819. Expend £629,900; on working stock— 14·99d.; locos only 4·31d.; receipts, 61 per cent. (i station), £123,287. The co structed a trolley line from 2½ miles long. This line is 2 80 kw. trans. from the station, and 2 80 kw. in s pressure of 500 v. is transfo station to 1,100 v., transmitt transformed down to 500–55

(10) **Ryde Pier Electric Ra** third rail; gauge, 4 ft. 8½ in gas engines drive Siemens g

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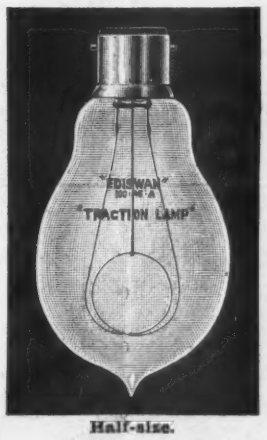

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ute 9 miles)	3	6	[illegible]	poles, bracket arm	60	[illegible]	[illegible] (bogie trucks)	weighing hoppers and economiser	Corliss hor. com. condensing, 94 r.p.m.	pole, 2,500 v., [illegible] alter., 25 ~ per sec.					
miles existing mls. projected)	4	8½	101 lbs.	Centre poles with brackets, side poles with span wires	135	—	G.E. 58	Lancashire.....	Vertical comp., marine type	Multipolar, direct coup.	2,600	—	—	—	—
miles single, miles double	3	6	65 lbs.	Bracket arm and span wire	40	10	2 Westinghouse, No. 46A	Babcock-Wilcox, 4 300 h.p.	4 300 h.p. Browett-Lindley comp. cond.	4 Westinghouse direct coupled, 200 kw.	800	—	—	—	—
m dbl., 4 m. sgl	4	8½	100 lbs.	——	—	—	Dick-Kerr	——	——	——	—	—	—	—	—
hiles	4	8½	100 lbs.	Bracket arms and centre poles	150	—	Dick-Kerr	——	——	——	—	£163,000	—	£159,401	£322,40
les	4	8½	90 lbs.	Span wire	30	8 (on order)	2 G.E. 50	Lancashire	Browett-Lindley	P. R. Jackson	—	—	—	—	—
miles single; 7 miles now eing equipped	3	6	92 lbs.	Side brackets chiefly, span wires and centre poles	20	—	Westinghouse, 2 25 h.p.	7 Lanc., 30 ft. by 7 ft. 6 ins.	2 Belliss, 150 h.p., 375 revs. p. m.; 1 Belliss, 700 h.p., 330 revs. p. m.	2 Westinghouse, 6-pole, 100 kw.; 1 do. 8-pole, 500 kw.	700	—	£120,000 including work in prog. *	£20,200	—
miles double, miles single	4	7¾	96 lbs.	Side bracket and span wire	80	—	2 25 h.p. Dick-Kerr	3 Babcock-Wilcox, and economiser	2 comp. Corliss, 640 h.p. 1 do. do. 320 h.p.	2 400 kw., 1 200 kw., multipolar, Dick-Kerr	1,000	—	£40,171 *	£48,562 *	£88,739 *
miles	4	0	87½ lbs.	Span wire and bracket arms	68 single truck	—	G.E. 800, and 58	(A) 4 Lancs., 30 ft. by 7 ft., economiser	(A) 2 McIntosh-Seymour, 2 Ball-Wood, 330 h.p., 1 Universal, 45 h.p.	(A) 4 G.E., 220 kw., 6 pole, 1 30 kw., 1 40 kw.	950	—	—	—	—
					20 bogie truck	—	Walker, 33N ..	(B) 3 30 ft. by 8 ft Lancs., economiser	(B) 2 350 h.p. vert. Browett-Lindley, 1 Alley-McLellan 35 h.p. com.	(B) 2 250 kw., 4 pole Bruce-Peebles, 1 30 kw.	530	—	—	—	—
miles running	4	8½	90 lbs.	Span wire and side brackets, centre trolley	36	—	2 G.E. 52	4 Lancs., 2 Babcock-Wilcox (destructor), supr-htrs. and econmsrs.	5 Willans, 1 500 h.p., 2 360 h.p., 2 200 h.p.	4 Mather-Platt, 4-pole; 1 Dick-Kerr multipolar	980	—	£51,500 *	—	—
miles single ..	4	8½	103 lbs.	Centre poles chiefly, and span wires	150	—	——	16 Lancashire, 30 ft. by 9 ft.	8 Browett-Lindley comp vert., 100 r.p.m., 1,600. h.p.	8 compound, 800 kw. direct coupled	6,400	—	—	—	—
miles single, miles double	4	8½	108½ lbs.	Centre and side poles, bracket arm, and span wires	220	—	G.E. 52	7 marine, Brown & Co., Ellis-Eaves induced draught	3 Allis hor. tand. compd. cond., 350 h.p. each 2 Cole, Mrchnt. & Morley vertical compound	3 G.E. 225 kw. each, 2 G.E. 500 kw.	1,675	—	—	—	—
miles single ..	4	8½	86 lbs.	Side and centre poles	20	8	Westinghouse	Babcock-Wilcox	Willans	Crompton	430	—	£10,000	—	—
miles	3	6	91 lbs.	Bracket arm	14	—	B.T.H.	3	3	3	500	—	—	—	£90,926
miles single, mile double	4	8½	87 lbs.	Side poles, bracket arms	15	—	2 25 h.p. Dick-Kerr	Lancashire *	2 Belliss, 330 i.h.p., 350 r.p.m.	2 Bruce-Peebles, 200 kw.	400	£11,149, rails only	£6,575 †	£14,245	£72,575 (estimate
iles	3	6	—	Side trolley	16	—	2 15 h.p., E.C.C.	3 Lanc., 30 ft. by 7 ft. ..	3 Musgrave, horizontal compd. cond., 125 h.p.	3 E.C.C., 90 kw. each, rope driven	270	—	—	—	—
miles single	4	8½	96 lbs.	Span wire and bracket arm, with side and centre poles	50	—	Dick-Kerr, 2 25 h.p. per car	4 Galloway, 28 ft. by 8 ft. 6 in., economiser	3 Belliss, enclosed direct coupled, 420 h.p. each, 400 rev. p.m.	3 Sunderland Forge 4-pole compound, 270 kw.	810	£96,000 (13·5 miles only)	£32,000	Approx. £30,000 (13·5 miles)	£158,000
miles; 3 miles ., 2½ double	4	8½	86 lbs.	Bracket arm and span wire	41	—	2 25 h.p. Westinghouse, Brush and B.T.H.	2 Babcock-Wilcox	2 Ball-Wood horizontal direct coupled	2 Westinghouse multipolar compound	400	—	—	—	—

ELECTRIC RAILWA

track, 4 ft. 8½ in.; rails, 100 lbs.; system of working, high tension with 4 transformer sub-stations; working current, 500 volts; 32 locomotives; 170 carriages (7 per train). Power station (Shepherd's Bush) equipment: — 16 Babcock-Wilcox water tube boilers, 6 Reynolds-Corliss horizontal compound condensing engines, 6 B.T.H three-phase alternators (5,000 volts); total capacity, 5,100 kw. General manager, G. C. Cuningham. Opened for traffic 30th July, 1900. Run, 3-minute service; 9 trains, 6 carriages per train. Passengers carried, 2,750,000 per month.

(3) **City and South London Electric Railway.**—MOORGATE STREET TO CLAPHAM COMMON.—Twin tunnels, 4¾ miles. Gauge of track, 4 ft. 8½ in.; weight of rails, 60 lbs. and 80 lbs. per yard; 32 electric locomotives. Annual car mileage, 468,500. The new power station contains 9 Economic boilers, 15 ft. by 8 ft. 9 in., 2 horizontal Corliss engines of 1,100 h.p. each, 2 500 h.p., and 2 250 h.p. Willans direct coupled to E.C.C. multipolar generators; total capacity, 2,800 kw. Manager, T. C. Jenkins. Electrical engineer, P. V. McMahon.

(4) **Great Northern & City Electric Railway.**—FINSBURY PARK TO MOORGATE STREET.—Underground tunnels. Messrs. Pearson & Son, Limited, contractors for the construction and equipment. Electric locomotives. Engineers, Sir Douglas Fox and Mr. Francis Fox. Generating station on Regent's Canal. Date of completion, June, 1902.

(5) **Waterloo and City Electric Railway.**—Twin C.I. tunnels; gauge, 4 ft. 8½ in.; rails, 87½ lbs.; 500 volts direct current; third rail between running rails; 17 motor cars; 10 trailers. Power station equipment:—Paxman Economic boilers, Belliss enclosed compound engines, Siemens generators; total capacity, 1,200 kw. Total capital outlay (to June 30, 1900), £589,073. Line opened August, 1898. Manager, C. J. Owens. Electrical engineer, D. Heap. Annual mileage, about 120,000 train miles per annum.

PROVINCIAL.

(6) **Bessbrook and Newry Tramway.**—Three miles double track; gauge, 3 ft.; rails, 41¼ lbs. Operated on third-rail system. Two motor cars; 26 trailers; 1 Mather-Platt 20 h.p. motor per car; chain gear (each motor car hauls 4 trailers). Power station equipped with 1 62 h.p. turbine at 290 revolutions per minute, driving by belt 2 Mather-Platt generators of 18 kw. each, at 1,000 revolutions per minute. Total capital issued,

£15,000.
Manage

(7) **Brighto**
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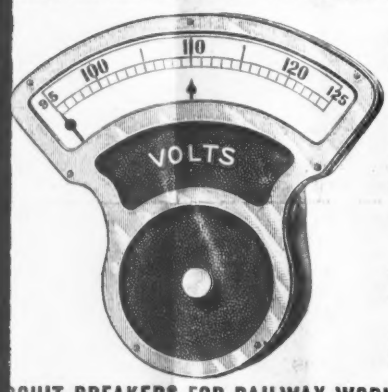

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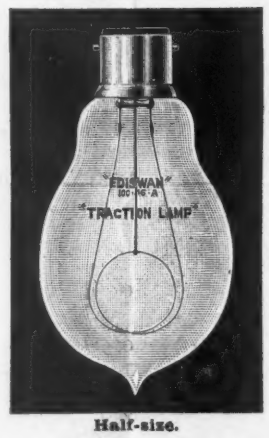

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WEST END SHOWROOM—53, PARLIAMENT STREET, S.W.

—	—	—	A. E. Le	Rossignol	—	—	—	Work in progress. Battery to be provided	Newcastle-on-Tyne .....(40)
—	—	July, 1900	A. N. Banister	A. N. Banister	—	—	—	———	Norwich .....(41)
—	—	—	J. Aldworth	H. Talbot ..	—	—	—	Arrangements now proceeding for equipment	Nottingham .....(42)
£159,401	£322,401	Dec.,'00	—	—	—	—	—	Work in progress under S. A. Pickering, Borough Engineer	Oldham .....(43)
—	—	June, 1899	E. H. Mottram (Suprtdt.)	J. A. Fraser (Power (Suprtdt.)	293,885 c m. 2,021,871 p.	6·0	59·34	Energy obtained from the Ashton-under-Lyne Corporation	Oldham, Ashton, and Hyde ..(44)
£20,200	—	Sept., 1899	C. R. Everson	J. H. Rider	Est.400,000 c.m.; abt. 4,000,000 p.	—	—	Tudor battery, 600 ampere hours in power station; do. 1,680 ampere hours in sub-station. * Combined lighting and traction plant.	Plymouth .....(45)
£48,562 *	£88,738 *	—	E. Rotter	E. Rotter	—	—	—	* Amounts of contracts placed to date	Portsmouth .....(46)
—	—	May, 1899	W. Slade- (Managing	Olver Engineer)	—	—	—	Capital issued £400,000. (A) Stoke-on-Trent power station	Potteries (North Staffordshire) (47)
—	—	—	—	—	—	—	—	(B) Maybank power station.	
—	—	July, 1899	J. F. Cutler	J. S. Highfield	600,000 c.m. 4,000,000 p.	—	—	Comb. ltg. and traction station, plant used for both purposes. New St. Helens and Dist. Tram. Co. work lines and own cars. 3 chloride batteries for storage. * Including part of ltg. plant.	St. Helens, Lancashire .....(48)
—	—	—	E. Hatton (Engineer)	F. A. Wilkinson (*pro tem.*)	—	—	—	Lines constructing	Salford .....(49)
—	—	Sept., 1899	A. L. C. Fell	A. L. C. Fell	—	—	—	Lines running, 16¼ miles double; 2½ miles single ..... Lines constructing, 1¾ miles double; ¾ mile single. Lines planned, 3½ miles double; 26¾ miles single.	Sheffield.....(50)
—	—	Jan. 1900	G. B. Carnon	F. H. Chaplin	600,000 c. m.	—	—	Lighting plant used for power also.....	Southampton .....(51)
—	£90,926	—	—	—	—	—	—	To be opened May, 1901. Borough Engineer, A. Fidler	Southend-on-Sea .....(52)
£14,245	£72,575 (estimated)	July, 1900	R. J. Wilson	C. D. Taite..	72,946 c.m. to date. 638,539 p.	—	—	Receipts per car mile 10·355d. * Steam from present lighting station. † Cost of engines, dynamos and switchboards only.	Southport .....(53)
—	—	Jan., 1893	J. J. Robins	J. J. Robins	257,312	—	—	Leased to South Staffordshire Tramways (Lessee) Co., Ltd.	South Staffordshire .....(54)
Approx. £30,000 (13·5 miles)	£158,000	Aug. 1900	W. Morrison	J. F. C. Snell	50,000 c.m. 984,344 p. *	—	—	Power supplied from extended lighting station. 23·4 miles single track in all to be constructed. * For three months.	Sunderland .....(55)
—	—	June, 1900	D. James ..	E. S. Rayner	—	5·03	42 %	———	Swansea .....(56)

LWAYS.

£15,000. Date of opening, October, 1885. Manager, J. Dawson. Engineer, J. L. D. Mears.

(7) **Brighton.**—VOLK'S ELECTRIC RAILWAY.—Third-rail system; 1 mile track (single) with turn-outs; gauge, 2 ft. 8½ in.; 35 lb. flat bottom rails. Five motor cars; 1 trailer; 1 motor to each car. Electrical equipment:—15 kw. Parker direct current transformer takes current at 230 volts, transformed down to 160 volts; 80 Tudor cells, H. A. 7, 120 ampere hours. Owner and manager of system, Magnus Volk.

(8) **Herne Bay Pier Electric Railway.**—Owned by the Herne Bay Pier Company, Ltd. ¾ mile; gauge, 3 ft.; third rail (angle bar beneath deck); one car; installation by B.T H. Co., driven by an 83 b.h.p. Stockport gas engine. Engineer, H. C. Dufton.

(9) **Liverpool Overhead Electric Railway.**—6½ miles double; gauge, 4 ft. 8½ in.; rails, 62 lbs. Third-rail system; 46 motor cars, 8 trailers, 48 car motors. Power station equipment includes 6 boilers, 7 engines, and generators of 2,300 kw. capacity. Date opened, March 6, 1893. Manager and electrical engineer, S. B. Cottrell. Annual train mileage, 802,784; passengers carried, 9,902,819. Expended on line opened, £629,900; on working stock—cost per car mileage, 14·99d.; locos only 4·31d.; ratio of expenses to receipts, 61 per cent. (including generating station), £123,287. The company has also constructed a trolley line from Seaforth to Crosby 2½ miles long. This line is worked by means of 2 80 kw. trans. from the railway generating station, and 2 80 kw. in sub-station. The line pressure of 500 v. is transformed up at the main station to 1,100 v., transmitted to sub-station and transformed down to 500–550 volts. for the line.

(10) **Ryde Pier Electric Railway.**—Half mile; third rail; gauge, 4 ft. 8½ in.; rails, 30 lbs. Two gas engines drive Siemens generator.

(11) **Southend-on-Sea Pier Electric Railway.**—Owned by Corporation. 1·5 miles of single and 300 yards of double; gauge, 3 ft. 6 in.; girder rails, 60 lbs., laid on wood sleepers, longitudinally on T iron joists; 2 66 i.h.p. compound engines; 2 Crompton compound dynamos, run in parallel; 12 cars, run in trains of three, centre being motor car; 100 passengers per train; outgoing circuit steel channel; rail return. Electrician, C. R. Norton.

(12) **Walton-on-the-Naze Pier Electric Railway.**—Owned by the Coast Development Company, Limited. Gauge, 3 ft. 6 in.; ordinary Vignoles rails, 36 lbs.; ¼ mile long; channel iron laid between rails on insulators; 3 motor cars; 3 trailers. Generating station plant:—1 semi-portable locomotive boiler, Shanks vertical compound engine, Parker generator, 20 kw. Opened August, 1898. Consulting engineer, G. L. Addenbrooke.

N

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THE CHLORIDE

ELECTRICAL STORAGE SYN., Ltd.,

Experts in Batteries for

ELECTRIC TRACTION,

will, on receipt of particulars, be pleased to submit you details of their patent

BOOSTER SYSTEM

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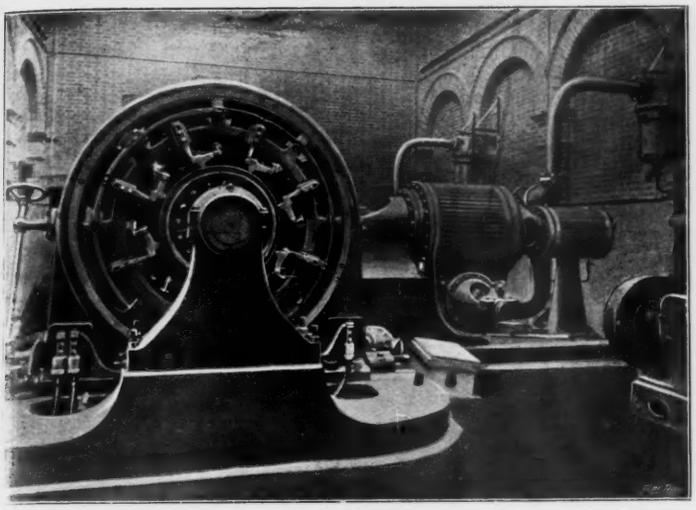
Caledonia Works, Halifax.

COPPER WIRE:

Anaconda Works, Salford, Manchester.



200-kw. Generating Set.

anel is also provided for measuring and registering the otal output of the station in watt-hours, amperes, and volts.

The feeder panels are of the usual type or traction work, each being provided with an automatic circuit breaker, illuminated dial ammeter, S.P. switch and lightning arrester.

The car shed lights, &c., and the motor-generator are controlled by main switches and automatics placed on a separate panel. The instruments and switches for the negative booster and motor-generator are separately mounted and placed in different parts of the engine room.

Each of the motor panels is provided with a General Electric Company's patent motor starter, so designed that in the event of a failure of current supply or breakage in the field circuits of the motor the latter is automatically switched out of circuit.

The framework of the board is of cast and wrought-iron, and is entirely self-supporting.

There are three trolley feeders and one track feeder. The trolley feeders run to Morriston, to Cwmbwrla, and to the centre of the town; they were made by Messrs. Callender's Cable and Construction Company, of their lead-covered type, and drawn into cast-iron pipes. The trolley wires are fed at intervals of half a mile, and the nearest feeding point is half a mile from the power station. Telephonic communication is provided between the station and all feeding points and termini.

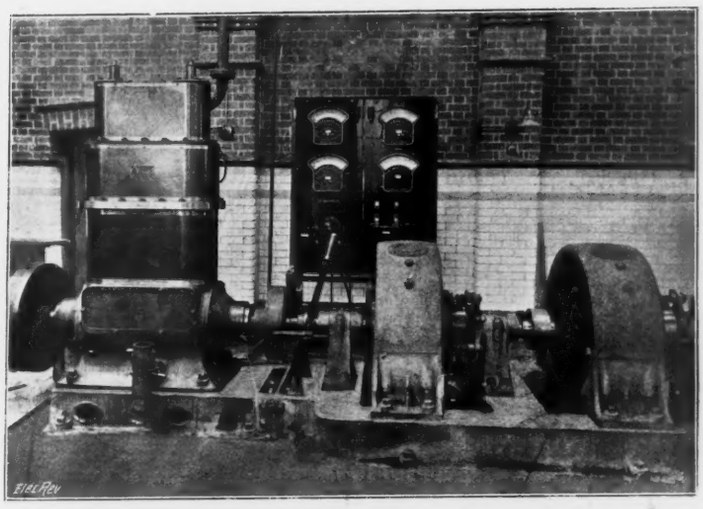
The return feeder, which joins the track at Morriston, is joined in series with the booster in the power station.

The trolley wires are 0·324 inch diameter, and are double throughout; they were made by Messrs. Roebling. The wire is carried over the centre of each track, and is supported by side or centre poles with bracket arms, or by span wire, according to local conditions, as shown in some of our views.

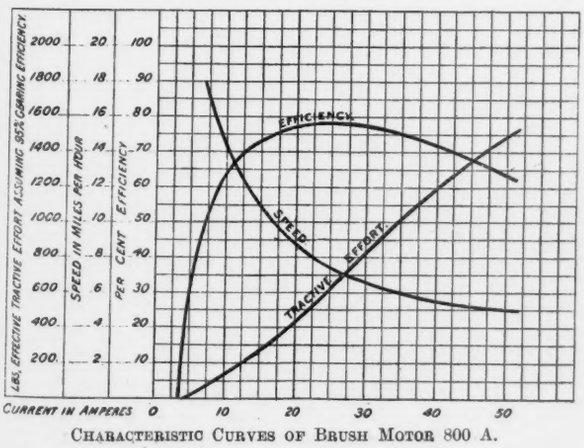
The poles are 31 feet in length, built of steel tubes in three sections, and weighing 832 lbs., 957 lbs., and 1,171 lbs., according to the stress they are to withstand; they were supplied by the National Tube Company, of America. The brackets are of steel tube, the double arms being 6 feet 6 inches long, while the single arms vary between 6 feet 6 inches and 18 feet 6 inches in length. The insulating materials were supplied by the Electric Equipment Company, of Birmingham, and the Ohio Brass Company, U.S.A.

The rolling stock consists of 26 single-deck four-wheeled cars and 15 single-deck double bogie cars. The car bodies were made by the Brush Electrical Engineering Company; the trucks used are of the "Lord Baltimore" and "Peckham" types. The wheel base of each truck is 6 feet 6 inches, and the wheels, which are of cast-iron, are 30 inches in diameter.

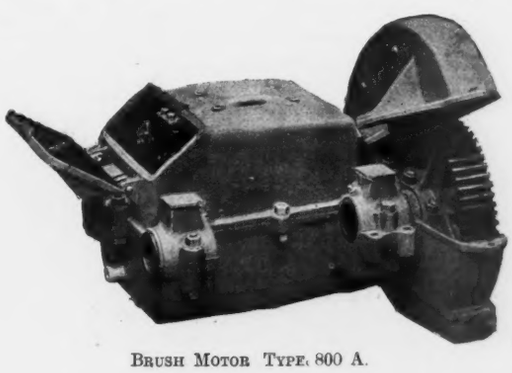
The short cars are 27 feet long over all, 17 feet 3 inches inside the body, and weigh 7 tons each when empty; they are capable of seating 26 passengers each. The long cars are 41 feet 6½ inches over all, and are divided inside into two compartments, each 14 feet 8 inches long; each of these



Combined Steam Dynamos and Motor-Generator.



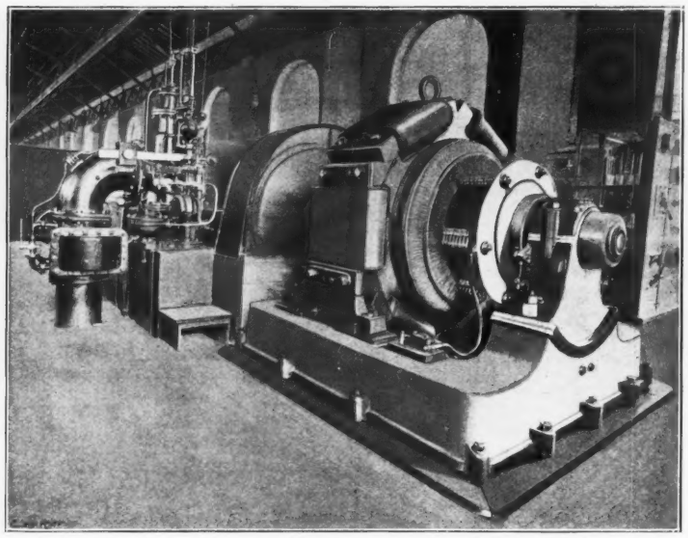
Characteristic Curves of Brush Motor 800 A.



Brush Motor Type 800 A.

cars weigh 9 tons empty, and seats 44 passengers. The large cars are furnished with Westinghouse rheostatic electric brakes, the small cars with emergency brakes; both types are provided with hand brakes in addition.

Each car is equipped with two motors; of these, 15 were supplied by the Brush Company; 15 by the Westinghouse, No. 46; and 11 by the General Electric Company, U.S.A., type G.E. 52. The controllers are of the G.E. K2 and the Westinghouse patterns. The pinions and spur wheels are all of steel.



Chèvres.—Hydro-Electric Generator.

The equipments furnished by the Brush Electrical Engineering Company consist of motors of the 800 A type, rated at 17 h.p. on the basis of 115° F. rise after one hour's run at rated output. We print a set of curves showing the characteristics of this class of motor. They give a very powerful starting torque, with relatively small current, and they are sufficiently fast to allow of a speed of 14 miles on the flat and of 8 miles on a gradient of 1 in 16.

The efficiency and pressure regulation of a system are enormously affected by the starting currents taken by the cars, and the luxury of high speeds on up-gradients is a very costly one, especially on narrow gauge lines where the axle space does not allow of suitable motors.

The long cars supplied by the Brush Electrical Engineering Company are mounted on Baltimore maximum traction trucks. The car bodies are of a somewhat unusual design, with closed ends and vestibule entrance on either side at the centre. This divides the car into two compartments, which may be used for smoking and non-smoking passengers. The appearance of these cars is exceedingly handsome; one of them was exhibited by the Brush Company at the recent Tramway Exhibition at Islington.

There are three car sheds, with 10 tracks of a total length of 1,100 feet: there are inspection pits under all the tracks, and a traverser over five tracks and the workshop provides for the ready handling of the cars. Repair shops of ample size are provided at the power station.

The system has been running since the end of June last, and already has proved entirely successful, as may be inferred from the fact that the working expenses are about 42 per cent. of the receipts. As the concession is of limited duration, it is, of course, essential that a substantial margin of profit should be realised, in order that the promoters may reimburse themselves for their initial outlay of something like £100,000.

The work of installing the new system was carried out under the supervision of Mr. H. M. Sayers, power engineer of the British Electric Traction Company. The concern is being carried on by the Swansea Improvements and Tramways Company, Mr. E. S. Rayner being the resident electrical engineer, and Mr. D. James the manager of the tramways.

We are indebted to the British Electric Traction Company for the particulars upon which this article is based, as well as for the accompanying illustrations.

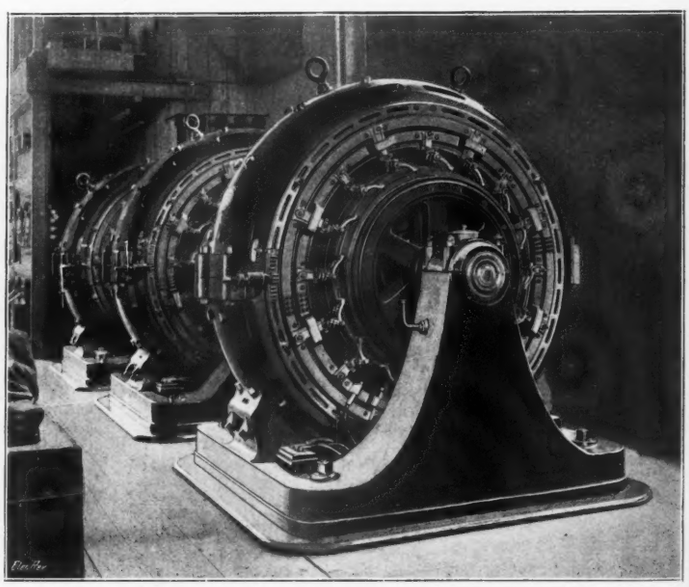
THE ELECTRICITY WORKS OF CHÈVRES (GENEVA).

(*Concluded from page 773.*)

Tramways and Lighting.

The tramway system and that part of the lighting system supplied by the old town works, being for continuous currents, the alternating current of the Chèvres Works is transformed by rotary converters, built by the Société d'Electricité Aliotte.

Converters for Lighting.—There are two of these machines, each having a capacity of 100 kw., in the central station of "l'Ile." Being required to give continuous current for a three-wire system, they have two independent windings on the armature, and they have, therefore, two commutators and two series of rings for the two-phase current. The armature core is slotted, and each slot has wires for the two windings, which are of the Gramme type, owing to the necessity of securing a proper number of commutator bars. The field magnet frame is of cast-steel, and the pole-pieces are screwed on. Four rings are fixed at each end, so that the two phases can be connected to each winding independently, in the case where one winding may be required to be used temporarily. Normally, however, each winding takes one phase.



Chèvres.—Rotary Converters for Tramways.

Transformers of 50 kw. per phase supply the converters. The armature is 100 millimetres in diameter by 400 long, and has 252 slots. There are 14 poles and seven sets of brushes

on each commutator. The weight of the armature is 3,000 kg., and of the whole machine 6,750 kg. Each commutator supplies a current of 450 amperes at 110 volts, and 385 revolutions per minute. The two-phase current is supplied at 70 volts; the ratio is therefore 1·56. The excitation required is 600 watts, and the efficiency of the machines 90 per cent.

Converters for Tramways.—There are three of these machines, each of 150 KW. capacity, placed in the turbine building at Coulouvrenière. They have one commutator for continuous current and four rings for the two-phase current. The winding is of the drum type. There are 320 coils of special shape, of 0·0025 metre diameter wire, placed in slots of the same number, which correspond to an equal number of commutator sections. Special attention has been given to the ventilation of the windings of these machines.

The frame is of cast-iron and the pole-pieces of cast-steel. In order to assist the magnetic flow from the steel to the iron the poles are widened out, so that at the surface of contact the section is twice that of the polar area.

The armature is 1,350 millimetres in diameter by 440 long, and has 320 slots. There are 16 poles and 8 sets of brushes. The weight of the armature is 2,900 kg., and of the complete machine 11,600 kg. The voltages are 360 : 560, and the normal continuous current 268 amperes, at 336 revolutions per minute. For excitation, 1,150 watts are required, and the efficiency is 90 per cent.

Transformers of 80 KW. per phase supply the converters.

For starting the rotary converters, liquid resistances were at first supplied. But the pressure required for starting is so small, that these were replaced by 5 KW. regulating transformers in parallel with the secondaries of the main transformers. By this means the converters can be started for the tramway work with a pressure of about 10 volts, and a current slightly exceeding that of normal full load.

In case of breakdown of the above rotary converters, a continuous current generator has been supplied and erected in the same building. It was made by the Compagnie de l'Industrie Electrique, and the turbine which drives it by Faesch & Piccard. On the same shaft as the turbine generator is a synchronous motor, taking power from the works at Chèvres, which drives the generator with or without the turbine, as occasion may require. It will thus be seen that every precaution has been taken that the tramway service should not be interrupted.

Waterworks Electric Pump.—In order to allow for the variation in power delivered to the waterworks during the times of high water in the summer, which necessitate the opening of the sluices of the right shore of the Rhône, the Town Council laid down at the Coulouvrenière Works a centrifugal pump, electrically driven from the Chèvres works. The motor, supplied by Messrs. Brown, Boveri and Co., is run by two-phase current at 2,500 volts, and takes at full load 186 amperes per phase, with a normal speed of 544 revolutions per minute. This motor is said to be the largest induction motor ever built. The pump, which has a duty of 1,000 H.P., was made by Sulzer Frères, of Winterthur. It is direct coupled to the motor, and can raise 380 litres per second to a height of 140 metres, or 400 litres to a height of 126 mètres. This pump was illustrated in our issue of September 28th.

Cost of the Works.

The credit of 3,000,000 francs voted by the Corporation for the execution of the first part of the work was quickly got through during the years 1893 to 1895; the opportunity being most favourable for the prompt sale of energy, many works which really belonged to the second period of construction were proceeded with without interruption. Thus the weir was constructed in its entirety for completely holding in the waters, the foundations of the turbine house were laid for the whole length—thus avoiding the cost of taking up the work later on below the level of the water—the mains were laid at once to a definite section, and machines Nos. 4 and 5 were ordered without delay, these not having figured in the first estimate. The Corporation accordingly voted fresh credits as the work required them from time to time. At the end of December, 1899, the work might have been considered completed. The total costs were approximately as follows:—

Surveys, &c.	£675
Weir	31,250
Head-race	6,350
Turbine house	51,500
Tail-race	4,050
Accessory works	1,440
Turbines and dynamos	150,000
Feeders, transformers, and sub-stations	95,000
Network in town	16,300
Buying out	10,200
Lands	2,140
Chèvres Bridge and approaches	1,350
Interest during construction	7,450
Unforeseen	6,200
Total	£383,905

Apparently, costs of production are not as carefully gone into on the Continent as they are in English municipal enterprises, so it is impossible to give any figures as to this important item. The budget for the year 1900, however, estimates a sum for net revenue which is equivalent to 5·78 per cent. of the capital invested in the work.

In conclusion, we have to express our thanks to Mons. C. Butticaz, director of the Services Industriels, of Geneva, and to the Corporation, for their courtesy in permitting us to present to our readers a description of this great undertaking, and to reproduce their drawings and photographs.

To all engineers who understand French, the book which the Corporation has published under the able editorship of Mons. Th. Turrettini, conseiller administratif, should prove invaluable. It is a veritable labour of love, containing, as it does, minute descriptions and calculations, besides diagrams, drawings and photographs of the work from its inception, and it is a fitting crown to one of the greatest and most enterprising municipal undertakings yet carried out.

ELECTRIC TRACTION NOTES.

(*Continued from page* 908.)

Underground Railway Schemes.—The various underground electric proposals are detailed in the *Daily News* in the annexed tabulated statement which gives approximately the mileage of metropolitan electric railways authorised, constructing, or projected. Railways opened—the Central London to the Bank, the City and South London to Moorgate Street, and the Waterloo and City, are excluded:—

Old Schemes, Constructing or Authorised.

	Miles.
Baker Street and Waterloo	5
Brompton and Piccadilly Circus	2
Charing Cross, Euston and Hampstead	5
City and Brixton	3½
City and South London (Moorgate Street to Angel extension)	2
District Railway Deep Level: Mansion House to Earl's Court	4½
Great Northern and City	3½
Great Northern and Strand	5
	30½

New Projects and Extensions of Railways already Authorised.

	Miles.
Brompton and Piccadilly Circus	4
Central London (extension to Liverpool Street and loop-lines)	1
Charing Cross, Euston, and Hampstead extensions	5
Hammersmith and district	5
City and North-East suburban	17
City and West End	6½
Islington and Euston	1½
King's Road	2½
North-East London	11
Piccadilly and City	2
Victoria, City, and Southern	7
West and South London Junction	4½
	67½

Runcorn—Warrington.—On Tuesday, at the Rural Council meeting, Messrs. Bennett & Ward Thomas, engineers, of Manchester, intimated their intention to again apply to the Light Railway Commissioners for a light railway between Runcorn and Warrington. The Council passed a resolution in favour of the scheme, subject to the width of the roads being satisfactory.

Sheffield.—Upon the invitation of Mr. A. L. C. Fell, M.I.E.E., a large number of the members of the Sheffield Society of Engineers and Metallurgists on Saturday afternoon inspected the Corporation electric power station at Kelham Island. At present the equipment consists of a range of seven boilers of the marine type, working at a pressure of 160 lbs. per square inch. The electrical generators comprise three 225-KW. sets and two 500-KW. sets, the former having American engines of the E. P. Allis type, and the latter having engines of the vertical type by Messrs. Cole, Marchant and Morley. An experiment is now being made by Mr. Fell with regard to methods of filtering condenser water for the purpose of feeding the boilers instead of using the more expensive town's

water supply. The total works cost at this station is 0·75d. per unit, including all running charges and repairs, and the total cost during the past six months, including interest on capital, sinking fund, insurance and head office charges, was 1·33d. per unit.

Sunderland.—It is reported that on Saturday last a telephone wire broke across the overhead trolley wire, and while hanging down was stepped upon by a horse which was instantly killed. The man who was driving the cart also received a slight shock.

TELEGRAPH AND TELEPHONE NOTES.

The American Pacific Cable.—In an editorial note on this scheme, the *Electrical World* writes as follows:—"We count upon seeing this cable made in America—a gutta-percha cable—and on the use of American ships and men to lay it; but meantime the prayer may be devoutly breathed for better luck than has attended previous American submarine efforts, the sad details of which we will not here recapitulate. Let us in this work go to school humbly to our British friends, who have girdled the globe with cable; and then having learned the lesson we shall be ready to teach them in turn—some time in the next century."

Grimsby Telephones.—As the financial prospects before municipal telephony are thought to be not particularly bright, the Lighting Committee, which has been considering the matter, recommends postponement for a time.

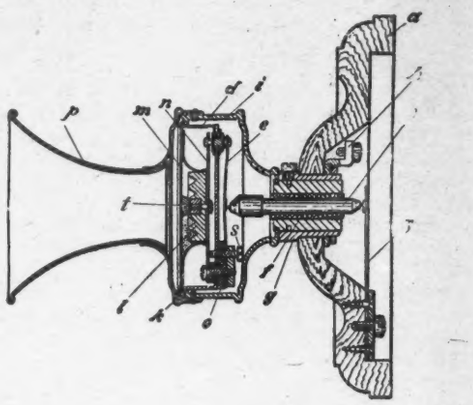
Manchester Telephones.—The Lord Mayor of Manchester received a deputation on 3rd inst. in regard to the telephone question and the granting of a licence to the Mutual Company. A memorial to the City Council signed by 520 merchants, manufacturers, traders, &c., was read by Mr. Fred. Scott, in which was pointed out the necessity for merchants and manufacturers in Manchester being able to communicate with their factories outside. On this account it was urged that the Mutual Telephone Company was in a better position for giving a satisfactory service than the Corporation. It was asked that the Corporation should now comply with the only condition necessary for the company to obtain a licence, which was by confirming their resolutions in support of the licence passed in 1897. After reading the memorial Mr. Scott said that Salford and some other outside authorities had already signed a requisition to the Postmaster-General, and for the districts thus covered the company had obtained a license, thereby saving it from extinction. A full licence could now be obtained if the support of the Manchester Corporation was given.

Mandalay.—A contemporary says that the Indian Government have granted a concession for 30 years to the Oriental Telephone Company, in Mandalay.

The New German Post Office Telephone Transmitter.—The German General Post Office in 1899 invited all the leading telephone manufacturers to enter into a competition for the construction of a microphone which would work equally well on *short* as on *long* distances. A great number of different type microphones were submitted to the Post Office, and the tests made with them were of a prolonged character, each pattern being subjected to most rigorous trials, and the data thus obtained were made the subject of a comparative report. We are informed that it was found that a granular carbon microphone, constructed by Mix & Genest, Limited, of Berlin, was the most suitable, and in consequence thereof 120,000 of these new microphones have since been ordered for subscribers' instruments. The characteristic features of the new transmitter (which

is, we learn, being sold at a very low figure) are a combination of carbon diaphragm, carbon granules, and carbon back on the one hand, and the interchangeability of these microphonic parts only. A metal capsule, the front of which carries the mouthpiece *p*, and behind such mouthpiece the carbon diaphragm *m*, contains the microphone. Opposite the diaphragm *m* is a grooved carbon disc *l*, which latter is brought into connection with the diaphragm in a peculiar manner which allows the greatest latitude to the free swinging of the diaphragm.

The carbon disc *l* is encircled by a strip of suitable soft cloth, the free edge of which has been fringed. The spread-out fringes are then glued to the diaphragm, so that between diaphragm *m* and carbon disc *l* an empty space is created which forms the receptacle for the carbon granules. In the centre of the disc *l* a cotton or woollen pad *t* is fixed which, with its free end, presses against the inner centre of the diaphragm, thereby damping same. The pressure is adjusted by means of a screw *s* which acts upon the spring *n* to



which is fixed the disc *l*. The metal capsule is retained in its position partly through the bayonet catch of the revolving microphone cover *i*, partly by the pressure which the bolt *c* brings to bear on the spring *e*, which latter is situated at the back of the microphonic part.

Both springs, *n* and *e*, are in electrical connection with each other, such connection being carried through the bushes, insulating same from the metal capsule. *g* forms the bearings for the pivot *f*; the ebonite-lined opening in the pivot allows the bolt *c* to penetrate the capsule while insulated from same.

The current enters at *h*, passes the revolving outer case *i*, enters through the metal front with which the carbon diaphragm is in connection, and goes *vid* microphone and bolt *c* to the spring *b*. *a* is a walnut rosette which forms the carrier for the whole outfit.

A wire gauze protects the diaphragm from damage in the usual manner. The adjustment of the damping arrangement is done by means of set screw *s*, and should only be carried out by the inspectors of the Telephone Company. If, for one reason or another, the microphone is beyond repair, there is no need for dismantling the instrument, but by simply unscrewing the front part of the capsule, the microphonic part becomes accessible; it can be detached with two fingers, and a new spare part inserted in the shortest possible time.

The microphone can be fixed to any existing telephone station, and its transmission, no matter whether on long or on short distances, is as clear as one could desire.

The great saving in cost derived by the interchangeability of the microphonic of essential part only, may be partly an explanation why such large quantities have been ordered by the German Government.

Telegrams to East Africa.—The Exchange Telegraph Company learns that, in connection with the relaxation of Censorship, the Postmaster-General notifies that, in addition to the codes already notified, the General Commercial and Mining Telegram Code, 1897, may now be used in telegrams to Cape Colony, Natal, Zanzibar, Seyschelles, Mauritius, Madagascar, British East Africa, German East Africa, Mozambique, and Lourenço Marques. Telegrams are, however, only accepted at the senders' risk.

Wireless Telegraphy.—A practical application of wireless telegraphy will shortly be put to test at Southend. A 30 feet mast has been erected on the pier for holding communication with passing vessels. Experts are to be sent by the Board of Trade, Trinity House, Lloyd's, and other public and private corporations to witness the tests. Similar apparatus has also been fitted at Sheerness and Shoeburyness.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—December 22nd. The E.L. Committee wants tenders for storage batteries. See "Official Notices" November 30th.

Asylum.—December 29th. The Committee of Visitors of the Winwick County Asylum, near Warrington, invites tenders for electric lighting, wiring, fittings, &c.

Ayr.—December 14th. The Tramways Committee wants tenders for overhead work, poles, brackets, section boxes, &c.; also underground work (feeders and other cables, conduits, trenching, &c.) for the electric tramways. See "Official Notices" November 30th.

Birkenhead.—December 18th. The Corporation wants tenders for steam, exhaust, feed water and drain pipe work for Craven Street generating station. See "Official Notices" to-day.

Belgium.—December 10th. The municipal authorities of Jumet are inviting tenders until December 10th for the supply and installation of a battery of accumulators having a capacity of 450 ampere-hours. Particulars may be obtained from, and tenders are to be sent to, Le Bourgmestre, Hotel Communal, Jumet, Belgium.

Bexhill.—December 10th. The U.D.C. wants tenders for water-tube boiler and pipework, and one 150-KW. steam dynamo. See "Official Notices" November 23rd.

Blackpool.—December 17th. The Corporation wants tenders for the supply of arc lamp carbons and oils for one year. See "Official Notices" November 23rd.

Brighton.—The Council invites tenders for the supply of unarmoured and armoured lead-covered electric cables for one year. See "Official Notices" to-day.

Brighton.—December 13th. The Council wants tenders for the construction of permanent way including bonding, &c.; paving all tramway tracks with wood, &c. See "Official Notices" November 16th.

Bristol.—December 20th. The Electrical Committee wants tenders for induced draught plant, steam and electric pumps, and water-softening plant. See "Official Notices" November 30th.

Copenhagen.—January 3rd, 1901. The Corporation invites tenders for three 530-KW. dynamos, switchboards, &c. See "Official Notices" November 23rd.

France.—December 21st. Tenders are being invited until the 21st inst., by the French Post and Telegraph authorities for the supply of 583 tons of copper wire. Tenders are to be sent to Le Sous Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris, whence particulars may be obtained.

Harrogate.—December 25th. The Corporation wants tenders for two Lancashire boilers, with economiser and fittings. See "Official Notices" November 30th.

Hendon.—December 31st. The U.D.C. wants tenders for Lancashire boilers, stokers, pumps and economiser; two 150-KW. steam dynamos, motor transformer, &c.; condensing plant, crane, switchboard work, battery, mains, meters, and workshop equipment for electricity works. See "Official Notices" November 16th.

Leeds.—December 10th. The Markets Committee invite tenders for the purchase of belt-driven electric lighting plant, now at the Kirkgate Market, comprising one pair of Robey's 30-B.H.P. gas engines; one pair of dynamos, made by Mr. Harding Churton, each 180 amps., 110 volts, 850 revolutions, including belting, water tanks, lamps, switchboard, and fittings. For further particulars apply at the City Engineer's office, Municipal Buildings, Leeds.

Leeds.—December 31st. The E.L. Committee invites tenders for two 1,400-KW. two-phase steam alternators and two sets of surface condensing plant. "*British manufacture.*" See "Official Notices" to-day.

Leigh.—December 17th. The Electricity and Tramway Committee wants tenders for mains, and for 1,000 220-volt incandescent lamps. See two "Official Notices" November 30th.

North-Eastern Railway.—December 10th. The directors want tenders for the undermentioned articles during the six months ending June 30th, 1901:—(1) Telegraph apparatus; (2) Telegraph wire and line stores. Forms of tender on application to Mr. Graves, Telegraph Department, York.

Paraguay.—January 15th. The municipality of Asomption, Paraguay, is inviting tenders for the electric lighting of the town. Bond, £600.

Portsmouth.—December 7th. The Corporation wants tenders for permanent way construction and underground feeders for the electric tramways; also for overhead electrical equipment., See two "Official Notices" November 23rd.

Rathmines.—January 10th. The District Council wants tenders for Lancashire boiler, 300-KW. steam dynamo, condensing apparatus and pipework, switchboard extension, mains, and public lighting (incandescent). See "Official Notices" November 30th.

St. Pancras.—December 20th. The Guardians are inviting tenders for the electric lighting of Cooks Terrace Infirmary. Clerk, Town Hall, Pancras Road.

Stavanger.—January 2nd. Tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Altesrig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by January 2nd, 1901. Further information may be obtained on application direct to Mr. E. Berentsen, British Vice-Consul, Stavanger.

Swansea.—December 17th. Tenders are wanted for wiring and fitting the public library and other buildings. See "Official Notices" to-day.

Swindon.—December 24th. The Corporation wants tenders for the supply of three high speed triple-expansion steam dynamos, balancer, and motor-generator for electricity works. See "Official Notices" November 30th.

CLOSED.

Cardiff.—The Tramways Committee has given the contract for cables to the B.I.W. Company, at £22,166. There were ten offers, the others being as follows:—Callender's Cable Company, £23,614 17s. 4d.; Messrs. W. T. Glover & Co., £23,468 5s.; Henley's Telegraph Company, £23,828 15s.; Messrs. Johnson & Phillips, £24,007; St. Helens Cable Company, £24,065; Messrs. Siemens, Limited, £22,656 5s. 7d.; the Telegraph Manufacturing Company, £23,702 5s. 4d.; the Union Cable Company, £24,762 19s. 5d., and the Western Electric Company, £22,667 12s. 1d. Messrs. J. Booth and Co. are to supply the crane at £685, and Messrs. Bruce Peebles and Co. a motor-generator at £1,041, and a Tudor battery at £1,260.

Glasgow.—For the lighting of the International Exhibition the following wiring contracts have been accepted:—

Machinery Hall—Lowdon Bros.	£327
Grand Avenue—Lowdon Bros.	214
Industrial Hall—Claud Hamilton, Limited	694

These figures do not include—700 arc lamps supplied free for the time of the Exhibition by the Brockie-Pell Arc Lamp Company, London, the arc lamp cables supplied free by Messrs. Frankenberg, Manchester, nor the main supply cables supplied by the British Insulated Wire Company, and some of the main fittings also free, but they include all incandescent wiring and fittings, arc lamp accessories, &c. These were the lowest tenders, the highest being £1,930 for Machinery Hall, £923 for Grand Avenue, and £3,300 for Industrial Hall.

Glasgow.—The tender of Messrs. Mechan & Sons as subcontractors to the British Westinghouse Company, has been accepted for the switchboard bus bars on the tramways.

Bootle.—The T.C. received 65 quotations for a steam dynamo, and have given the contract to the Electric Construction Company's tender at £2,263 for a Belliss triple-expansion engine and E.C.C. dynamo.

FORTHCOMING EVENTS.

Friday, December 7th.—At 4.0 p.m. Institution of Electrical Engineers. Students' visit to the Electrical Standards Laboratory of the Board of Trade, 8, Richmond Terrace, Whitehall.

At 8 p.m.—The Faradian Club. Lecture on "The Modern Steam Engine," by J. S. Raworth.

6.30 to 11 p.m.—Northampton Institute. Annual prize distribution and conversazione. Sir J. A. Cockburn, Agent-General for South Australia, will distribute the prizes.

Saturday, December 8th.—At 3 p.m. Visit of Institution of Junior Engineers to the London United Tramways Company's electric generating station at High Road, Chiswick.

Institution of Electrical Engineers. Students' visit to the Manchester Square station of the Metropolitan Electric Supply Company.

Monday, December 10th.—At 8 p.m. Society of Arts, Cantor Lectures. "Electric Oscillations and Electric Waves," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Four lectures. Lecture III.—"The Electro-Magnetic Medium." The two constants of the medium—The unitary ratio "v"—Study of dielectric constants—Maxwell's law—Low temperature effects.

Institution of Electrical Engineers (Newcastle-on-Tyne Section), Meeting at College of Science, Newcastle.

Tuesday, December 11th.—Institution of Electrical Engineers (Manchester Section). Meeting at Owens College, Manchester. Mr. F. B. Behr on "Proposed Manchester and Liverpool Express Railway" (lantern slide illustrations).

At 8 p.m.—The Institution of Civil Engineers. Ordinary meeting. Papers to be read and discussed:—(1) "The Signalling on the Waterloo and City Railway," and (2) "Note on the Signalling of Outlying Siding Connections," by Alfred Weeks Szlumper, M.Inst.C.E.; (3) "Signalling on the Liverpool Overhead Railway," by Stephen Butler Cottrell, M.Inst.C.E.

Wednesday, December 12th.—At 8 p.m. Institution of Electrical Engineers (Glasgow Section). Meeting at the Institution of Engineers and Shipbuilders, Bath Street. Discussion on paper read in London on Thursday, November 29th, "On the Supersession of the Steam by the Electric Locomotive," by W. E. Langdon.

At 2.30 p.m.—Institution of Civil Engineers. Students' visit to the engine works of Messrs. James Simpson and Co.

At 8 p.m.—The Electro-Harmonic Society Smoking Concert at the St. James's Hall Restaurant.

Thursday, December 13th.—At 8 p.m.—Institution of Electrical Engineers, (meeting at the Institution of Civil Engineers, Great George Street, S.W.) W. Duddell on "Rapid Variations in the Current through the Direct Current Arc." (This announcement is subject to the conclusion of the discussion on Mr. Langdon's paper at the previous meeting).

Friday, December 14th.—At 8 p.m. Institution of Mechanical Engineers, Storey's Gate, S.W. "Power Gas and Large Gas Engines for Central Stations," by H. A. Humphrey, Northwich.

At 5 p.m.—Physical Society. At the Physical Laboratory of the Royal College of Science, Exhibition Road, South Kensington (by invitation of Prof. Rücker):—"Electric Inertia," by Prof. A. Schuster, F.R.S.; "The Effect of Inertia on Electric Currents in a Rotating Sphere," by Prof. A. Schuster, F.R.S.; "Exhibition and Description of a Quartz-Thread Gravity Balance," by Prof. R. Threlfall, F.R.S.; "On the Theory of Magnetic Disturbances by Earth Currents," by Prof. A. W. Rücker, F.R.S.; "Notes on the Practical Application of the Theory of Magnetic Disturbances by Earth Currents," by Dr. R. T. Glazebrook, F.R.S.; "The New Physical Laboratories of the Royal College of Science," by Prof. A. W. Rücker, F.R.S.

At 8 p.m.—Institution of Junior Engineers. At the Westminster Palace Hotel. Paper on "The Metallurgy of Tin," by Mr. J. H. Davy James.

NOTES.

The Institution of Electrical Engineers.—Subject to the discussion on Mr. Langdon's paper being concluded at the meeting held at the Institution of Mechanical Engineers on the 6th inst., the following paper will be read at the Institution of Civil Engineers on the 13th inst., viz., "Rapid Variations in the Current through the Direct Current Arc," (illustrated by experiments), by W. Duddell, associate.

On Thursday, November 29th, the Dublin Section of the Institution of Electrical Engineers held their first conversazione at the Lecture Theatre of the Royal Dublin Society. Those present were received by Prof. G. F. and Mrs. FitzGerald, and the proceedings, which were highly successful, comprised an exhibition of various electrical experiments and apparatus by members and others. There was also a short lecture on "Rotating Magnetic Fields," illustrated experimentally by the chairman, Prof. G. F. FitzGerald, F.R.S., and a similar lecture, illustrated by lantern slides, by Prof. W. F. Barrett, F.R.S., on "The Permeability of certain Alloys of Iron and Steel." In addition there was an excellent short musical programme. Among the very numerous exhibits may be specially mentioned: A new form of Meldometer, for determining the *softening* points of minerals, Dr. J. Joly, F.R.S.; the Action of Radio-active Material on Electric Discharge, Dr. F. J. Trouton, F.R.S.; Frictional Electrical Machine, date very early in eighteenth century; original Page Electro-Magnetic Engine, exhibited in the great Exhibition of 1851, A. E. Porte and J. R. Sykes; Meteorological Instrument with Electrical Recorders, A. Yeates; X-Ray Exhibition, Dr. W. Haughton; Electric Lamp, movable on rails, A. Guinness, Son & Co., Limited; Tramway and Power Distribution, material and instruments, A. Jacob; System of Telephoning, as applied to electric traction, J. Y. Fletcher; Tram Material, as used in Dublin, J. W. Towle, R. H. Humphries, P. S. Sheardown, and S. G. Redman; various types of House Meters, G. F. Pilditch.

The Glasgow section will discuss Mr. Langdon's paper on December 12th. Mr. R. F. Yorke's paper on "Water-Power" has consequently been deferred until the January meeting.

Explosion at Chicago.—The Central News says that a disastrous explosion has occurred at the generating station of the North-Western Railroad, in Chicago. The building was destroyed. Five persons were killed and 13 injured.

The Pacific Cable Scheme.—It is announced by the Colonial Office that the Pacific Cable Committee have accepted, on behalf of Her Majesty's Government, and of the Governments of Canada, New South Wales, Victoria, Queensland, and New Zealand, the tender of the Telegraph Construction and Maintenance Company for the manufacture and laying of the projected Pacific cable. The amount of the tender is £1,795,000, and the work is to be completed by the end of 1902. The cable will run from Vancouver to Queensland and New Zealand, *viâ* Fanning Island, Fiji, and Norfolk Island. The *Daily Telegraph* says:—"The total length of cable will be considerably over 7,000 miles, and the stretch from Vancouver to Fanning Island—approximately 3,500 miles—will be the longest cable in the world. The section from Fanning Island to Norfolk Island will be about 1,700 miles, from Norfolk Island to Brisbane 800 miles, and from Norfolk Island to the coast of New Zealand 500 miles. The American scheme for a cable between San Francisco and Honolulu has not got beyond the stage of having been favourably reported upon to Congress. In all the earlier British Pacific cable schemes, Honolulu was selected as the landing place of the first section, but on the annexation of the Sandwich Islands by the United States this was, of course, impossible, seeing that the cable was 'all-British.' The contingency of American ownership of the Sandwich Islands was, however, foreseen as far back as 1888, and in order to provide against it Fanning Island was in that year annexed to the British Empire. The new Pacific cable, which will form the longest link in the all-British telegraph route to the greatest of the British Colonies, is the most important undertaking of the kind ever carried out under a single scheme. The other long-distance cables were mostly carried out in sections from time to time, as the necessities of commerce demanded. The exceptions are the trans-Atlantic lines and the recently laid cable from the Cape *viâ* St. Helena. In length the Pacific cable will be the longest direct wire in the world, as it will cover a distance of nearly 9,000 miles in all. The manufacture of such a vast line is in itself a big task, and will occupy the greater portion of the time allowed for the establishment of communication. The actual work of laying these long cables is by no means so difficult as it was in the days when the *Great Eastern* steamed across the Atlantic with the first American cable. Improved methods and machinery have reduced what was formerly a most serious undertaking, accompanied by much risk of failure, to practically mathematical certainty."

The Royal Society.—The annual report of the Council, which was submitted to the anniversary meeting of the Society last Friday, refers, among many other matters, to electric railway disturbances, the Hughes bequest, and the electric lighting of H.M. Office of Works, as follows:—

Electric Railway Disturbances.—The Committee appointed by the Board of Trade to investigate this question has made experiments near Stockton and in London with instruments devised by Mr. W. Watson, Assistant Professor of Physics in the Royal College of Science. No definite decision has yet been arrived at by the Board of Trade, but the matter continues to be a subject of grave anxiety to those interested in the protection of observatories and laboratories from extraneous disturbances.

Hughes Bequest.—Under the will of the late Prof. Hughes, a bequest of £4,000 has been made to the Royal Society with a direction to award the income annually as a prize, either in money or in the form of a medal, for the reward of original discovery in physical sciences. After full consideration it has been decided to award annually a gold medal, to be called the Hughes medal, not exceeding in value the sum of £20, together with the balance of the income to such person as the President and Council may consider the most worthy recipient, without restriction of sex or nationality, as the reward of original discovery in the physical sciences, particularly electricity and magnetism.

Electric Lighting.—In consequence of an intimation received from Her Majesty's Office of Works that the system of electric lighting was not considered satisfactory by that Department, the Council has, on the recommendation of the House Committee, sanctioned the execution of extensive alterations in order to bring the installation up to the standard of modern requirements. It has also, on the recommendation of the Committee, arranged for the permanent supply of alternating current to the building, and for the extension of the direct current main leads, an arrangement which will, it is hoped, prove both convenient and economical on the occasions of the Society's *soirées*. The Council desires to record its sense of the great obligation it is under to Prof. Ayrton for placing his professional skill and much of his valuable time at the service of the Society in this matter.

The Electrical Engineer Volunteers.—We are informed that the President, Council, and Members of the Institution of Electrical Engineers are arranging for a reception of the Active Service Contingent of the Electrical Engineers, Royal Engineers, Volunteers (due home at the end of this week) on the evening of Tuesday, December 18th, in the Covent Garden Opera House, which has been generously placed at their disposal by Mr. Rendle and Mr. Forsyth for this purpose. Ladies will be invited. A circular announcing the arrangements is about to be distributed among the members.

We learn that at the dinner, of which Mr. Edmunds is hon. treasurer, to be given at the Prince's Restaurant on Monday, December 17th, the chair will be taken by Prof. Perry, the President of the Institution of Electrical Engineers, as Lord Kelvin, who presided at the send-off dinner given by the same group of hosts, is unavoidably prevented from attending. We are asked to remind those who intend to be present at the dinner to send in their applications as early as possible. In the event of there being vacancies through hosts at the previous meeting not being able to attend, applications will be dealt with in the order of date as they may arrive, for such seats as may be to spare.

The Accident on the City and South London Railway.—Major J. W. Pringle's report to the Board of Trade, on the accident that occurred about 5.28 p.m. on September 26th, between the London Bridge and Bank stations of the City and South London Electric Railway, has been published. It states, says the *Times*, that owing to the failure of an armature an up train (No. 14), consisting of a locomotive and three eight-wheel passenger coaches, came to a stand in the up line tunnel, and whilst it was in this position the following up train (No. 13), of similar composition, and travelling on the same line, got into the same block section, and collided with it. Both trains were fitted with the Westinghouse automatic brake, which seems to have been in good working order. The damage done was not great. Eleven passengers complained of shock, but none appear to have been seriously injured. All the platform lights at the Bank station, as well as the electric lights in the two trains concerned, and in the signal lamps between the Bank and London Bridge stations, were put out by the collision setting up a short circuit. Major Pringle reports:—"The cause of this accident is clear—viz., two trains were in one block section at the same time. It is also clear that all the signalling arrangements were in good order at both stations two minutes before the collision took place, and the accident cannot therefore be attributed to derangement in the signals. It does not appear likely that signalman Barnes had sufficient reason or time to tamper with the release key-box, and I therefore feel myself compelled to reject the supposition that the outer home signal was 'off' when train No. 13 passed it, and to give it as my opinion that Driver Ironmonger and his assistant Geers passed the signal when it was at danger, and are responsible for the collision." Major Pringle also states that the evidence points to the block rules having been broken on at least one other occasion, a very serious matter when the block sections are so short as on the City and South London Railway, and suggests that any tampering with the release-key boxes without opening them by the keys kept by the station inspectors should be rendered impossible.

Gloves for C.S. Engineers.—The Association des Industriels de France Contre les Accidents du Travail some months ago opened a competition for a special protective and insulating glove for the use of working electrical engineers. The competition, full particulars of which can be obtained from the Association, at 3, Rue de Lutece, Paris, closes on December 31st next.

Automobile Electric Traction from Modena to Bologna.—The Adriatic Railway Company has proposed to the Minister of Public Works to institute an electric automobile service between Modena and Bologna. The cars will have two classes, viz., second and third, and a carrying capacity of 68 persons. This new service is now being inaugurated.

The Metropolitan Railway and Electric Traction.—The directors on Monday opened the tenders for applying electricity on portions of the Underground Railway. The meeting was held at the offices of the joint Committee of the two companies at 7, Victoria Street, and there was a full attendance of directors. Numerous proposals were received, but, in view of the important nature of the contract, the directors came to no decision on the subject.

We understand that among the tenders submitted to the Committee is a combined proposal on the part of Messrs. Mather & Platt, Messrs. Siemens Bros. & Co., and the Thames Ironworks; these three parties have arranged to divide the work between them, but each firm independently guarantees the execution of the whole. The technical and financial qualifications of this strong combination are undoubted, and their manufacturing facilities are such as to ensure quick delivery—one of the most necessary requirements of the case.

Wireless Telegraphy.—The Belgian packet *Princess Clementine*, which is fitted with the Marconi apparatus, found it necessary recently during a gale to lower the topmast to which the aerial conductor was fixed. It was at first supposed that the considerable reduction in the height of the conductor which this entailed would render communication with the land stations impossible; but this, on trial, was found not to be the case. Throughout the voyage communication was kept up with Ostend, and when off Dover a message was sent to Dovercourt, Essex. The *Standard* records some equally successful telegraphy to mail steamers at sea off the cost of Germany. Numerous experiments are now being made with the system in Germany, not only by the Post and Telegraph Departments, but also by the military authorities. The latter recently established a connection by wireless telegraphy between the Brocken, the highest mountain in North Germany, and the Kyffhäuser, the highest summit in Thuringia, a distance of about 60 kilometres. Prof. Braun, of Strasburg, is said to have recently made great improvements on Marconi's apparatus. He has discovered that there is a definite limit to the distance when the electric waves are generated in a primary wire, however strong the currents may be. He therefore employs waves in a primary to generate waves in a secondary conductor, as in the induction coil, and these latter waves are used for the transmission. Leyden jars are discharged through the primary to excite the waves. The waves generated in the transmitter are quite harmless. The range of Prof. Braun's transmitting apparatus is said to be three times that of Marconi's. But the range given (62 kilometres) does not come up to Marconi's record.

Personal.—Mr. Andrew S. Dunn, late telegraph superintendent of the Caledonian Railway Company, has been presented by Her Majesty the Queen with a beautiful silver inkstand, enclosed in a handsome morocco case, with an inscription as follows on the lids of the silver inkbottles:—"Presented to Mr. A. S. Dunn by Queen Victoria, November, 1900." On the inkstand there is also the monogram V.I.R. surmounted by the Crown. In a letter from Her Majesty's secretary, Sir Fleetwood Edwards, addressed to Mr. Irvine Kempt, general superintendent of the Caledonian Railway, Sir Fleetwood says: "The Queen understands that Mr. Dunn, telegraph superintendent of the Caledonian Railway, has recently retired. Her Majesty accordingly commands me to forward herewith a silver inkstand, which I would ask you to be good enough to present to Mr. Dunn as a mark of the Queen's appreciation of the attentive personal service that he has for some years past rendered when travelling in Her Majesty's train o and from Balmoral."

Mr. C. E. Davies, of Bolton, has been appointed chief assistant electrical engineer to the tramway engineer at Cardiff.

American Invasion.—It is now said that American experts are ready to invest large sums of money in improving suburban transportation in connection with the surface and underground lines of London. For months past experts have been at work in the districts surrounding London, for 30 miles in every direction, and they are making elaborate reports upon the conditions of communication, and the needs of the people.—*Westminster Gazette*.

Obituary.—We regret to have to record the death of Mr. Joseph Webster, Sectional Engineer of the Postal Telegraph Department, Lincoln. The deceased, who was only 40 years of age, was a most valuable officer, and his services were held in high esteem by the Post Office officials. Mr. Webster joined the service at Leeds, and was afterwards transferred to the Superintending Engineer's Office, North Midland District, Nottingham, being subsequently appointed to the Lincoln section.

Appointments Vacant.—A mains superintendent is wanted for York. A meter superintendent and wiring installation inspector are required for Greenock. An assistant engineer is wanted for the Grimsby electricity department at £120 per annum. The Lancaster Corporation wants an electrical engineer, at £300 per annum, to inaugurate the new tramways system. A resident electrical engineer at £300 per annum is required for the Ilford electricity works. The Battersea Borough Council wants an electrical engineer at £350 per annum. A resident electrical engineer at £300 per annum is required for Perth. See "Official Notices" this week.

Royal Institution.—The lecture arrangements before Easter include the following:—Prof. J. A. Ewing, six lectures on "Practical Mechanics" (experimentally treated), first principles and modern illustrations; The Right Hon. Lord Rayleigh, six lectures on "Sound and Vibrations." The Friday evening meetings will begin on January 18th, when a discourse will be delivered by Prof. Dewar on the "Gases at the Beginning and End of the Century."

Correspondence.—We have received, too late for insertion in this issue, a letter from Mr. Theodore G. Chambers in reply to Mr. Oppermann's letter on the "Electrical Vehicle Trials."

Technical Education.—The President of the Board of Education has appointed a committee consisting of:—Sir William de W. Abney, K.C.B., F.R.S. (chairman); Sir Philip Magnus; Sir Swire Smith; Mr. G. R. Redgrave; Mr. W. Bousfield; Mr. W. Vibart Dixon; with Mr. A. E. Cooper, Board of Education, South Kensington, as secretary, to consider the best means for co-ordinating the technological work of the Board of Education with that at present carried on by other educational organisations.

Change of Address.—The Consolidated Telephone Construction and Manufacturing Company are, on 20th inst., moving from Shaftesbury Avenue to more commodious premises at 38, Victoria Street, S.W.

NEW COMPANIES REGISTERED.

Brisbane Electric Tramways Investment Company, Limited (67,853).—This company was registered on November 20th, with a capital of £750,000 in £5 shares, to adopt agreements (1) with W. H. Adams, and (2) with the Brisbane Tramways Company, Limited, and to carry on the business of tramway and light railway constructors and owners, electricians, contractors, manufacturers of electrical and other plant, machinery, motors, cables, wires, accumulators and apparatus, builders of cars, omnibuses, and rolling stock, carriers of passengers and goods, &c. The first subscribers (each with one share) are:—J. B. Concanon, 28, Austin Friars, E.C., stockbroker; H. R. Beeton, 6A, Austin Friars, E.C., stockbroker; A. P. Ledward, 29, Langland Gardens, N.W., gentleman; A. M. Kyd, 71, Cazenove Road, N., gentleman; G. Prynn, Nithsdale, West Cliff Parade, Southend, gentleman; T. B. Robinson, 3-4, Lime Street Square, E.C., merchant; and R. Gambles, 3-4, Lime Street Square, E.C., secretary. The number of directors is not to be less than three nor more than seven; the first are to be appointed by the subscribers; qualification, £500; remuneration, £1,000 per annum, divisible.

Isidor Frankenburg & Co., Limited (67,889).—This company was registered on November 22nd, with a capital of £25,000 in £10 shares, to acquire, take over as a going concern, and carry on the business of a manufacturer of and dealer in waterproof, rubber and leather goods and electric cables now carried on by Isidor Frankenburg, at the Greengate Rubber Works, Greengate, Salford, Lancs., and to adopt an agreement with the said vendor. The first subscribers (each with one share) are:—Isidor Frankenburg, Greengate Rubber Works, Salford, manufacturer; Merton F. Frankenburg, Greengate Rubber Works, Salford, manufacturer; Ralph J. Frankenburg, Greengate Rubber Works, Salford, manufacturer; Carl O. Weber, Ph.D, Greengate Rubber Works, Salford, consulting chemist; Isaac Kriegsfield, Greengate Rubber Works, manager of garment works; H. G. Mabbs, Greengate Rubber Works, manager of cable works; S. T. Rowe, Greengate Rubber Works, Salford, buyer; and Herbert Standring, Greengate Rubber Works, Salford, secretary. The first directors are Isidor Frankenburg (permanent governing director, special qualification £1,000 shares), Merton F. Frankenburg and Ralph J. Frankenburg; ordinary qualification, £1,000; remuneration of governing director, £630 per annum; others as fixed by the company. Registered office, Greengate Rubber Works, Greengate, Salford, Lancs.

New Century Arc Light Company, Limited (67,849).—This company was registered on November 19th, with a capital of £30,000 in £1 shares (5,000 preference), to adopt an agreement with W. G. Davis, and to carry on the business of electricians, mechanical engineers, suppliers of electricity for light, heat, power, or other purposes, &c. The first subscribers (each with one share) are:—R. Blewett, 22, Grove Road, Wanstead, articled clerk; C. Rose-Cran, 13, Lancashire Road, South Hampstead, law student; J. H. Oliver, 2, Beresford Villas, Park Terrace, Southend-on-Sea, managing clerk; W. Brider, 43, Appach Road, S.W., clerk; S. C. Whittle, 40, Carlingford, N., accountant; J. Feil, 53, Klondike Road, Balham, S.W., secretary; and A. Lowry, 248, Thorold Road, Ilford, accountant. The number of directors is not to be less than two nor more than seven; the first are M. Bush and A. C. Schonberg; qualification, £200; remuneration, £100 each per annum and £450 for the chairman. Registered office, 28, Victoria Street, S.W.

SUPPLY STATION ACCOUNTS.

Tunbridge Wells Corporation Electricity Accounts.

The accounts of the Tunbridge Wells electricity department for last year show that the business is steadily growing. Mr. H. L. P. Boot, the engineer, in his report mentions the fact that the additional connections to the mains have brought the number of lamps supplied to a figure equal to the number of inhabitants in the borough. Large extensions are in hand and nearing completion; although they do not come into the accounts now presented, having been commenced in February of this year, they were contemplated early in 1899. The buildings will enable an additional 24,000 lamps to be connected, and it is estimated that at the present rate of progress further expenditure on bricks and mortar will not be necessary for some 10 or 12 years. At present five Babcock boilers are in use, but owing to the difficulties with smoke and the exceptionally hard water taken as boiler feed the new steam-raising plant will be of the Lancashire type with superheaters. A condensing plant will be put in, with water reservoir and cooling tower. A 400-KW. Willans-Ferranti set being laid down will bring the total installed plant capacity up to 1,070 KW. The distribution system is being improved by the abolition of house transformers, while the mains laid aggregate about 40 miles in length.

The capital expenditure is still small for the size of the works, particulars of which may be summarised thus:—

GENERAL STATEMENT.

	1898.	1899.	Increase.
Total capital expenditure ...	£37,818	**£42,843**	£5,025
Number of units sold	334,709	**496,297**	161,588
Number of lamps connected ...	24,000	**28,502**	4,502
Gross revenue	£7,381	**£8,291**	£910
Gross expenditure	3,486	**£5,170**	1,684
Gross profit	3,895	**£3,121**	−774
Average price per unit sold ...	5·12d.	**3·57d.**	−1·55d.

When reviewing the 1898 accounts, we expressed the opinion that street lighting was being rather neglected. This is about to be remedied, as the Council during last year decided to add 262 incandescent lamps, and the borough will now be lighted electrically throughout, except in the outlying streets, where no cables are laid. Mr. Boot states that the average price obtained from private consumers alone was 4·8d. per unit, and for public lighting, after deducting the cost of carbons, repairs, and trimmers' wages, the low figure of 1·19d. per unit. Owing to the reduction in price, the receipts have been caused to dwindle per unit, and no less than 40 per cent. of the output to private consumers was sold at 3d. per unit. The average prices obtained from different classes of consumers is as follows:—

Public houses, &c. ...	3·9d.	Shops	4·8d.
Private houses ...	4·9d.	Offices, &c. ...	6·0d.

Revenue Statement.

	1898. Gross.	Per unit.	1899. Gross.	Per unit.	Increase.
Sale of energy	£7,138	5·12d.	£7,381	3·57d.	−1·55d.
Meter rents, &c.	209	·15d.	266	·13d.	− ·02d.
Attending public lamps ..	...	...	553	·27d.	+ ·27d.
Sale of ashes, &c.	8	·00d.	22	·01d.	+ ·01d.
Sundry fees	26	·02d.	69	·03d.	+ ·01d.
Gross revenue ...	£7,381	5·29d.	£8,291	4·01d.	−1·28d.

The increase in the price of coal has affected the works costs, and complaints as to quality of fuel have been made showing that even at the higher prices coal has been a difficulty. The other items on the cost sheet remain either the same as in 1898 or have fallen, with the result that the + ·15d. on works cost is wiped out, and total costs remain unaltered at 2½d. Eliminating distribution and street lighting expenditure the works costs stand at 1·63d., and total cost at under 2·33d.

Cost of Production.

	1898. Gross.	Per unit.	1899. Gross.	Per unit.	Increase.
Coal	£1,351	·97d.	£2,446	1·18d.	+ ·21d.
Oil, waste, water and engine room stores	146	·11d.	220	·11d.	·00d.
Salaries and wages incurred in generation and distribution	632	·45d.	787	·38d.	− ·07d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	155	·11d.	254	·12d.	+ ·01d.
Works cost ...	£2,284	1·64d.	£3,707	1·79d.	+ ·15d.
Rent, rates and taxes ..	213	·15d.	300	·14d.	− ·01d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	814	·58d.	1,048	·51d.	− ·07d.
General establishment charges, stationery and printing, law charges and insurance	175	·13d.	115	·06d.	− ·07d.
Other expenses	...	...	...	...	...
Total costs ...	£3,486	2·50d.	£5,170	2·50d.	·00d.

The net profits have been adversely affected by the reduction in price for supply. Had no change been made, they would last year have been £3,130. Financial charges have increased by £633, and now represent 1·14d. per unit. The net profit is now £765 (or ·37d. per unit), and this added to the balance brought forward, gives a sum of over £2,000, out of which the Council have been recommended to devote £1,000 to the reserve fund.

Profit Statement.

	1898.	1899.
Interest on loans..	£890	£1,214
Sinking fund for repayments	833	1,142
Net profit carried to credit of rates	900	...
„ „ being surplus..	130	765
„ „ expended in increasing pressure, &c.	1,142	...
Gross profit	£3,895	£3,121

CITY NOTES.

Kalgoorlie Electric Power and Lighting Company.

The first report to September 30th, to be submitted to the meeting to be held in London on 10th inst., states that the progress of the operations of the Corporation from unforeseen causes has been considerably delayed. These include obtaining a freehold title to property; also deciding upon the most suitable plant for evaporating the salt water obtained from the well already sunk. To aid the Board to obviate these difficulties an alternative site was proposed but was found to be unsuitable. A satisfactory solution has now been arrived at, as regards both evaporating and condensing plant. This, however, involves the expenditure of more capital per H.P. than was originally intended, and it is now found that instead of £150,000 producing a plant of 4,500 I.H.P., it will cost the Corporation £135,000 to erect a plant capable of producing 2,400 I.H.P. The Corporation's consulting engineers estimate that the net earnings on this plant will be about 16 per cent. on £200,000. The works have been so planned that additional H.P. will cost very much less in proportion, and further, that when the Government water scheme is carried out, the production of electricity can be largely increased at a small cost. The Board recommend the erection of the plant as quickly as possible, and orders for such portions as are at present difficult to obtain, owing to the congested state of engineering works, have been already placed, and will shortly be ready for delivery. A shaft to serve as a well, or for mining purposes, has been sunk, and a steam winding plant erected. Large cross-cuts are now being driven to serve as reservoirs. A supply of water has been cut amounting to 24,000 gallons per 24 hours, which is considered sufficient for the Corporation's needs. In sinking the well a lode formation was intersected which by assay showed gold. Should good lodes be bisected in cutting the reservoirs, it is the intention of the Board to form a separate syndicate, or company, to develop the mining rights.

The India-Rubber, Gutta-Percha and Telegraph Works Company, Limited.

The directors' report for the year ending September 30th, 1900, to be presented at the meeting next Thursday, says that the accounts show, after provision for doubtful debts, a net profit for the past 12 months of £67,238 18s. Adding £31,511 8s. 10d. brought forward, and deducting £12,500 interim dividend paid in June, there remains a disposable balance of £86,250 6s. 10d. The directors recommend the distribution of 15s. a share, free of income tax, amounting to £37,500, making with the interim dividend paid in June, a total payment of 10 per cent. for the year, and leaving £48,750 6s. 10d. to be carried forward. The general business has been fairly profitable, although the price of raw material continued high. The cable steamer *Buccaneer* has been employed on charter to the Western Telegraph Company, and the ss. *Silvertown* laid a cable between New York and Canso (Nova Scotia) for the Commercial Cable Company. Since the closing of the financial year the manufacture and shipment of another cable for the same company has been completed, and the ss. *Silvertown* is now awaiting orders to proceed with the laying between Waterville (in Ireland) and Weston-super-Mare. The works at Silvertown and Persan have been maintained in their usual state of high efficiency. The employment of electricity for the transmission of power in the former is being extended. The board has sent a representative to South Africa with the view of opening an agency there. Major Leonard Darwin and Mr. Robert Kaye Gray, the retiring directors, offer themselves for re-election.

Allgemeine Elektricitäts-Gesellschaft.

The report on the business of this famous German electrical company for the past year (1899—1900) shows steady progress in output and the maintenance of the former high rate of interest (15 per cent.) on capital. The directors, however, appear to have some foreboding of a coming depression in the electrical industry, and provide for this by increasing the contribution to the reserve fund. To show the advance they have made on last year, they state that this year they have turned out 16,418 machines, having a total output capacity of 153,241 KW., while last year the numbers were 11,438 machines, having an output capacity of 145,499 KW. The total number of employés of the company in October this year was 17,361. The yearly output of incandescent lamps has increased by 1 million. A new branch for the manufacture of the Nernst lamp has been added to this department. After some successful experiments with this lamp in small towns, the company has now begun to introduce them in Berlin. The delay in the wholesale production of these lamps, is said to be due to the time which it takes to train workmen in their manufacture. The company evidently believes in the invention and anticipates in the future a great demand. The number of electric lighting and electric traction installations which the company have carried out at home and abroad are too numerous to mention. For the transmission of power, they assert that polyphase systems are fast taking the leading place. The capital of the company is now £3,000,000. The Electrical Company, Limited, of 122 and 124, Charing Cross Road, are the sole representatives of the A.E.G. for Great Britain and Ireland.

Venezuela Telephone and Electrical Appliances Company, Limited.

Sir Douglas Fox presided at the meeting of this company held at the offices in Lombard Street on Tuesday. He referred to the bad trade and political disturbances in Caracas which caused a falling off in the general business. Nevertheless, the accounts showed a a profit of £6,763, and after providing for debenture interest and preference dividend up to June 30th, a balance of £1,959 remained. Their manager had informed them that a severe earthquake had occurred in Caracas since the date of the accounts, and they were to be congratulated that more damage was not done to their property. It had not really been seriously interfered with, but the earthquake had had its effect on the general business, and some of their telephones would have to be removed. The board regarded it as prudent, in view of all the circumstances, to "pass" the dividend. Matters were now improving, and if the political world kept quiet —which seemed almost impossible in that country—the company would have a good future. The report was adopted.

Prospectuses.

The subscription list of the *South Lancashire Electric Traction and Power Company, Limited*, opened on Monday last and closed on Wednesday. The share capital of the company is £850,000, divided into 600,000 6 per cent. cumulative preference shares and 250,000 ordinary shares, all of £1. £750,000 4½ per cent. first mortgage debenture stock has also been created. The debenture stock and £400,000 of the preference shares have been offered for subscription. Under the scheme, a complete system of electric traction in South Lancashire will be established with cars running between Liverpool and Manchester, through Prescot, St. Helens and other towns in the district, and with branch connections from the main line to Wigan, Bolton and other important centres. The company intend to supply energy for lighting, and to work goods traffic. Under the South Lancashire Tramways Act of 1900, the company will enjoy the right of using the lines for aminimum period of 51 years.

by Isidor Frankenburg, at the Greengate Rubber Works, Greengate,

An estimate of profits is given, which, taking an annual average of 5,000,000 car miles run, with gross receipts 9d. per car mile, shows a net profit of £84,375 per annum. This is, of course, when the complete system gets to work. The purchase price has been fixed at £350,000, payable as to £50,000 in cash, £50,000 in preference shares, and the balance in ordinary shares. The vendors are J. B. and J. Atherton, who have borne the expenses of securing powers, forming companies, and generally promoting the undertakings which are included in the scheme. Mr. A. H. Gibbings is the engineer-in-chief, and Kincaid, Waller & Manville are consulting engineers. The secretary is Mr. A. Tracey, 41, Castle Street, Liverpool.

The London and Westminster Bank is authorised to receive subscriptions at £5 5s. per share for 13,363 £5 six per cent. cumulative preference shares of *Edmundson's Electricity Corporation, Limited*, forming part of 20,000 similar shares, the remainder of which—6,637—were subscribed for at the same price by the share and debenture stockholders of the company in August last. The present issue is made for the purpose of providing funds for the completion of central stations which are now in progress in Montrose, Brechin, Melton Mowbray, Lymington, Sandown and Shanklin. The list is expected to close to-day.

The Electric Timber Seasoning Company.—The second ordinary general meeting of this company was held at Charlton on Tuesday, Mr. E. H. Stevenson presiding. The report to June 25th, 1900, was adopted. It showed that the works are now finished and equipped for economical operation, the working of the process having been also begun. Mr. W. C. Johnson and the Comte de Montaigu have resigned directorships. It was stated that the drying chambers at the works are designed on an entirely new principle invented by Prof. Hearson, a director.

Western Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share (6 per cent. per annum), for the quarter ended September 30th last, and payable on December 21st. The transfer books will be closed from December 14th to 20th.

St. Helens Cable Company.—The directors have declared a dividend of 6 per cent. The transfer books are closed from 1st to 10th inst.

Stock Exchange Notices.—The Committee has appointed special settling days as under:—Wednesday, December 12th: Castner-Kellner Alkali Company, Limited.—Further issue of 150,000 shares of £1 each, fully paid, Nos. 300,001 to 450,000, and has ordered same to be quoted in the Official List.

TRAFFIC RECEIPTS.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending November 24th were £136; corresponding period last year, £161; decrease, £25. Total to date, £19,712; corresponding period last year, £19,737; decrease, £25.

Bristol Tramways and Carriage Company.—The receipts for the week ending November 30th were £2,987 9s. 3d.; corresponding period last year, £2,696 11s. 10d.; increase, £290 17s. 5d.

Central London Railway.—The receipts for the week ending December 1st were £5,766; previous week, £5,755; increase, £11. Total receipts to date (18 weeks), £93,687. Miles open, 6.

City and South London Railway.—The receipts for the week ending December 2nd were £1,904; corresponding week last year, £1,053; increase, £851. Total to date, £35,860; corresponding period last year, £21,561; increase, £14,299. Miles open, 1900, 4½; 1899, 3½.

Cork Electric Tramways and Lighting Company.—The receipts for the week ending November 29th were £327 6s. 10d.; corresponding week last year, £359 10s. 10d.; decrease, £32 4s. 0d. Total to date, £19,647 0s. 9d.; corresponding period last year, £18,216 16s. 11d.; increase, £1,430 3s. 10d.

Dover Corporation Tramways.—The receipts for the week ending December 1st were £157 12s. 7½d.; corresponding week last year, £154 10s. 3d.; increase, £3 2s. 4½d. Total to date, £9,920 8s. 5½d.; corresponding period last year, £9,463 14s. 2d.; increase, £457 14s. 3½d. Miles of track open, 1900, 3; 1899, 3. Car miles run, 1900, 4,982; 1899, 4,783. Number of cars, 1900, 11; 1899, 11.

Dublin United Tramways Company.—The receipts for the week ending November 30th were as follows:—D. U. T. Co., electric cars, £3,265 8s. 11d.; ditto, horse cars, £294 15s. 10d.; D. S. D. Co., electric cars, £651 3s. 8d.; total, £3,941 8s. 5d; corresponding week last year—D. U. T. Co., electric cars, £2,754 11s. 8d.; ditto, horse cars, £171 16s. 7d.; D. S. D. Co., electric cars, £665 6s. 6d.; total, £3,591 14s. 9d.; increase, £349 13s. 8d.; aggregate to date, £103,014 17s. 7d.; aggregate to date last year, £92,343 16s. 2d.; increase, £10,671 1s. 5d. The mileage worked is 44 miles electrically, 1 mile by horses, as against 36 miles electrically, 8 miles by horses, for the corresponding period last year.

Liverpool Overhead Railway.—The receipts for the week ending December 2nd were £1,569; corresponding week last year, £1,747; decrease, £178. Total from July 1st, 1900, £86,649; ditto corresponding period last year, £86,029; increase, £620. Miles open, 6·67 chains. 1899 includes date of embarkation of troops for South Africa.

STOCKS AND SHARES.

Wednesday Evening.

The demand for electrical supply shares and Debentures shows no sign of slackening, and the dealers in the market are experiencing what they describe as a comparatively good time. Notwithstanding the activity, prices show little or no fluctuation. It is in the telegraph section that the principal changes have occurred this week, the break in the Eastern division somewhat demoralising the rest of the list. The electric railway market is dull, Waterloo and City stock excepted, and the prospect of a "tube" mania does not invigorate the securities already known in the Stock Exchange. There is a better feeling in the manufacturing section, largely due to the Telegraph Construction Company having secured the contract for making and laying the Pacific cable, and traction shares are, in the majority of cases, harder.

Our last week's *exposé* of the British Street Electric Tramways Company was followed by a host of condemnatory notices in other journals, and it is to be hoped that the number of people who subscribed is exceedingly small. That there were some who disregarded the warning is shown by the complaint of one applicant, who averred that he received an allotment of shares in a suspiciously short time after sending in his papers. Needless to say, there is no price in the market, nor is it likely there will be one.

Traction shares generally are harder, British Electric Ordinary being 10s. better, the Preferences unchanged, Buenos Ayres and Belgrano electric trams have been an active market on the excellent traffics lately cabled across. Some of the improvement is, no doubt, due to the visit of the Brazilian President to Buenos Ayres, but the line appears, beyond this ephemeral cause, to be doing well. Singularly enough, the "A" Preference are entirely neglected, the demand running on the "B" shares, which are now 4⅜. The "A" issue at 5½ looks as though it might go better; it is entitled to a 6 per cent. cumulative Preferential dividend.

Cape Electric Tramway shares are now *ex* both dividend and bonus. The price of the new shares is 1s. premium, and Thursday, December 6th, the last day for applying. No money becomes payable until next New Year's Day.

The South Lancashire Electric Traction and Power Company, of which we gave brief particulars last week, does not commend itself to the Stock Exchange. It is pointed out that the purchase price is exceedingly high, and, considering the area over which the company is to operate, the working capital appears to be inadequate. Consequently no market has been made in either the company's shares or Debentures. On the other hand, the Edmundson's Preference issue commands investors' attention, and shares are changing hands on the basis of ⅛ to ⅜ premium. The security for these shares, which have been publicly offered, is quite sufficient.

As regards the other supply companies, the market for Metropolitans continues dull, and although no further call is recorded there have been a good many sellers about this week. The eterna squabble with the Marylebone authorities is at the bottom of the trouble.

Pronounced flatness has overtaken the shares of the "Twopenny Tube." Central London Ordinary have been done as low as 9½, and all sorts of reasons are assigned for the slumplet. One is that the railway's sleepers are wearing out at an alarming rate; another, that litigation is threatened by some of the householders in the West End because the vibration caused by the C.L.R. trains is damaging their property. Our own impression is that a "bear" clique is deliberately "raiding" the market for its own purposes. The lowest price touched by the shares during the current year is 8 13/16, but we do not see any indication of the present fall being carried to this extent. City and South London stock is still under its new issue cloud, but Waterloo and City Ordinary has put on a point.

Telegraph Construction and Maintenance shares have risen to 40 on the announcement referred to in our opening paragraph. The company and its shareholders are to be congratulated upon having secured the contract for the new cable, and the market in manufacturing shares, as a whole, should go better. The Telegraph Construction having this work on hand, will not be able to undertake very much else for another two years; and kindred concerns, now that their principal competitor is full of work, must benefit by securing orders that might otherwise go to the Telegraph Construction Company. Allowing for the dividend, there has been a drop of 6s. in Telegraph Manufacturing Ordinary shares, but the Preference do not move.

Telegraph securities are weak. There is a good deal of undigested stock in the market, and any fresh sales serve to accentuate the weakness. Eastern Ordinary, after keeping at 142½ all the week, fell to 140½ this afternoon (Wednesday), and Eastern Extension shares also shed ¼. The senior securities of the companies are weak, and the dulness extends to Indo-European Telegraph shares. Cuba Telegraph shares have lost 10s., both as regards Ordinary and Preference. The issue of a new Havana Tramways Company, to which we have previously referred, is again postponed, owing to the action of the American syndicate interested in the scheme.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years.			Closing Quotation Nov. 28th.	Closing Quotations December 5th.	Business done during week ended December 5th, 1900.	
			1897.	1898.	1899.			Highest.	Lowest.
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —103	99 —103	...	...
119,700	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	85 — 90	85 — 90	...	...
822,700	Anglo-American Telegraph	Stock	3 %	£3 9s.	73/6	53 — 56	53 — 56	...	...
3,088,540	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	98 — 100	97 — 99	99½	98¼
3,088,540	Do. do. Deferred	Stock	...	18s. %	£1 7s.	10½— 11	10¼— 10⅝	10⅝	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	3 %	4 %	3 — 3½	3 — 3½	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	8 %	165 —175	165 —175	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —105	102 —104	103¼	103
16,000	Cuba Telegraph	10	7 %	8 %	7 %	6½— 7½	6 — 7	7	6
6,000	Do. 10 % Pref.	10	10 %	10 %	...	14½— 15½	15 — 16	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 —104%	100 —104 %	...	...
60,710£	Direct United States Cable	20	3¾%	3½%	3 %	10¼— 10⅜	10¼— 10⅜	10⅜	10¼
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	140 —145	138 —143	143	140
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	97 —100	96 — 99	97	96
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	...	112 —116	110 —114	113	...
250,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	14 — 14½	13¾— 14¼	14¼	13 13/16
50,000	Do. Nos. 250,001 to 300,000 (iss. at £3 pm. all pd.) £6 pd.	10	...	...	...	6¼— 6¾	9¼— 9¾	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	113 —118	113 —118	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	100 —103	100 —103	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	99 —102%	99—102%	...	...
180,227	Globe Telegraph and Trust	10	4½%	5⅛%	5¼%	10¼— 10⅜	10¼— 10⅜	10⅜	10 5/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	15 — 15½	15 — 15½	15 7/16	15¼
150,000	Great Northern Telegraph, of Copenhagen	10	10 %	12½%	...	31 — 33	31 — 33	31	...
84,300	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	49 — 53	48 — 52	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	...	...	104 —107	104 —107	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680	1	...	...	2½%	½— ½	½— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	4 %	5 %	¾— 1	¾— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	6 %	5 %	4⅜— 4⅝	4⅜— 4⅝	4½	4⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	12½	..
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	6 %	5 — 5¼	5 — 5¼	5	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	96 — 99	96 —99	...	...
500,000	Do. 4 % Deb. Stock Red.	100	...	...	...	101 —104	101 —104	103	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅞— 1⅛	⅞— 1⅛	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	...	...	101 —104	101 —104	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	125 —130	124 —129	124	...
58,000	United River Plate Telephone	5	5 %	6 %	7 %	4½— 5	4½— 5	...	...
16,639	Do. do. 5 % Cum. pref. Nos. 1—16,639	5	...	...	...	5 — 5½	5 — 5½	...	...
23,361	Do. do. Nos. 16,640 to 40,000 £3½ pd.	5	...	...	...	3¼— 3¾	3¼— 3¾	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	107	...
171,000	West African Telegraph, 5 % Debs.	100	...	...	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	100 —103	100 —103	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	7 %	14 — 14½	14 — 14½	14 3/16	14
75,000	Do do. 5 % Debs. 2nd series, 1906	100	...	...	...	103 —106	103 —106	...	...
348,777	Do. do. 4 % Deb. Stock Red.	100	...	...	...	102 —105	102 —105	...	...
88,321	West India and Panama Telegraph	10	⅜%	2 %	⅜%	¾— 1	⅝— 7/8xd	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	...	...	6½— 7½	6 — 7 xd	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	...	...	5 — 7	5 — 7 xd	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	105 —108	105 —108	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	6 %	7 — 8	7 — 8	...	...
12,000	Do. do. 7 % Cum. Pref.	5	7 %	...	...	8½— 9½	8½— 9½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	9 %	9½— 10½	9½— 10½	10	9⅜
20,000	Do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 6	5½— 6	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	6 %	6⅞— 7	6⅞— 7	7	6 5/16
150,000	Do. do. do. % Deb. Stock Red.	Stock	4½%	...	...	110 —113	110 —113	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579	10	10 %	6 %	4 %	9 — 10	9 — 10	10	9⅜
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	13 — 14	13 — 14	13⅜	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	125 —130	125 —130	128	126½
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	*nil*	4 %	8½— 9½	8½— 9½	9 1/16	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	11 — 12	11 — 12	11¾	11½
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd.	...	...	...	...	108 —111	108 —111	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	5 %	7 %	...	4½— 5	4½— 5	...	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock.	100	...	...	...	101 —104	101 —104	...	...
110,000	London Electric Supply Corporation, Limited, Ord.	3	...	...	...	1⅞— 2¼	1⅞— 2¼	...	...
49,840	Do. do. do. do. 6 % Pref.	5	...	6 %	...	4½— 5½	4½— 5½	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	100 —102	100 —102	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	5 %	12½— 13½	12½— 13½	13½	12⅝
220,000£	Do. 4½% First Mortgage Debenture Stock	...	4½%	...	...	112 —115	112 —115	...	...
250,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	97 —100	97 —100	99½	...
6,452	Notting Hill Electric Lighting	10	6 %	6 %	7 %	14½— 15½	14½— 15½	14 15/16	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15 — 16	15 — 16	15⅝	..
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 9	8 — 9	8¾	...
150,000	Do. do. 3½ % Deb. Stock Red.	100	...	...	...	100 —103	100 —103	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000	Do. do. 4 % Deb.	100	...	..	...	85 — 95	85 — 95	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2½— 3½	2½— 3½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000	5	12 %	12 %	13 %	12 — 13	12 — 13	12 1/16	12 1/16

* Subject to Founders Shares.
Unless otherwise stated all shares are fully paid.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.

what they describe as a comparatively good time. Notwithstanding

of the American syndicate interested in the scheme.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation Nov. 28th.	Closing Quotation Dec. 5th.	Business done week ended Dec. 5th, 1900. Highest	Lowest
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	9 — 10	9 — 10	...	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	91 — 95	91 — 95	...	...
45,000	British Electric Traction	10	...	6 %	...	13¼— 14½	14 — 15	14 9/16	14⅛
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	12 — 13	12 11/16	12½
350,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	120 —123	120 —123	122	121¾
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	7/16— 9/16	½— ¾	...	...
50,000	† Do do. 6 % Cum.Pref., 1—50,000 ...	...	...	...	...	½— ⅝	⅝— ⅞	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	97 — 99	97 — 99	...	...
70,000	British Insulated Wire Ord.	5	15 %	15 %	20 %	10 — 11	10 — 11	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅜— 6¼	5⅜— 6¼	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	3 %	5 %	6 %	1⅝— 1⅞	1⅝— 1⅞	1¾	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	6 %	2 — 2¼	2 — 2¼	2 3/16	2⅛
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	106 —111	106 —111	...	...
108,710	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	103 —105	103 —105	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	12½%	15 %	15 %	12½— 13½	12½— 13½	12 15/16	12 7/8
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5¼— 5⅝	5¼— 5⅝	5⅝	5½
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	S ock	...	...	...	110 —114	110 —114	...	...
206,297	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	9¼— 9⅝	10⅝	9½
78,703	Do. do. Pref. half-shares	5	...	...	...	5 — 5½	4 — 4½	5½	4 13/16
78,703	Do. do. Def. do.	5	...	...	...	5 — 5½	4½— 5	4 13/16	...
855,000	City and South London Railway	Stock	1½%	2½%	1½%	52 — 56	52 — 56	...	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	4½— 5½	4½— 5½	4¼	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	...	6 %	7½%	3½— 4	3½— 4	...	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	99 —102	99 —102	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	6 %	1⅞— 2¼	1⅞— 2¼	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	6 %	3½— 4½	3½— 4½	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	90 — 92	90 — 92	...	...
100,000	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	96 —100	96 —100	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	2 — 2¼	2 — 2¼	2⅛	2
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	7 %	...	2⅜— 3¼	2⅜— 3¼	2⅜	...
182,500	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	102 —105	102 —105	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	7 %	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	12½%	14½%	15 %	12½— 13½	12½— 13½	12⅝	...
30,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	...	5½— 5⅝	5½— 5⅝	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	...	...	108 —112	108 —112	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	21½	21¼
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	100 —103	100—103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3½%	3⅜%	8 1/16— 8 5/16	8⅜— 8⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5	13¼— 13½	13¼— 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	37 — 42	38 — 42	41½	37⅜
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...%	101 —104	101 —104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	...	8 %	12 %	10½— 11⅜	10 — 11 xd	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5¼— 5⅝	5¼— 5⅝	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	3 %	3 %	92 — 95	93 — 96	94⅜	...

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Brompton and Kensington, 4½ % Debentures of £100, 103—106.
National Electric Free Wiring, 12/6 paid, ⅜—½.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 16½—17½.
Do. do. Pref. (£10 pd.), 10—10½.
* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6 % £5 (fully paid), 6⅜—7⅛. Debentures, 102—105. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 16⅜.

Bank rate of discount 4 per cent. (July 19th, 1900).

MARKET QUOTATIONS, Wednesday, December 5th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a ,, ,,	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17 10	£17 10	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25	£25	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3¼d.	3¼d.	..
a ,, Caustic (75/80%) ..	per ton	£34	£34	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	64/-	64/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
a ,, Bichromate, casks ..	per lb.	2¾d.	2¾d.	..

METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£80 to £145	£80 to £150	..
c Brass (rolled metal 2" to 12") basis	per lb.	7⅞d.	7⅞d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	8½d.	8½d.	..
c ,, Wire, basis	per lb.	8¼d.	8¼d.	..
c Copper Tubes (brazed) ..	per lb.	11¼d.	11¼d.	..
c ,, ,, (solid drawn) ..	per lb.	11d.	11d.	..
g Copper Bars (best selected) ..	per ton	£86	£86	..

METALS, &c, *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£86	£86	..
g ,, Rod	per ton	£86	£86	..
c ,, (Electrolytic) Bars ..	per ton	£83 10	£83 10	..
c ,, ,, Sheets ..	per ton	£92	£92	..
c ,, ,, Rod ..	per ton	£85 10	£85 10	..
c ,, ,, H.C. Wire	per lb.	9¾d.	9¾d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	8/6	8/6	..
h India-rubber, Para fine	per lb.	3/8½ to 3/9½	3/11 to 4/1	dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	60/7½	63/9	2s. 1½d. dec.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£11 10	£11 15	5s. dec.
g Lead, English Ingot	per ton	£17 to £17 2 6	£17 5 to £17 7 6	5s. dec.
g ,, ,, Sheet	per ton	£19	£19	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£3 18	£3 18	..
p Silicium Bronze Wire	per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i ,, ,, in bars		£58	£58	..
g Tin, block	per ton	£128 to £129	£131 to £132	£3 dec.
g ,, foil	per lb.	2/-	2/-	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	9½d.	9½d.	..
j ,, Best Flax, 6 lea.	per lb.	5½d.	5½d.	..
j ,, Hemp, 3 ply 10 lbs. ..	per lb.	4½d.	4½d.	..
j ,, ,, Russian, 10 lbs. ..	per lb.	5½d.	5½d.	..
j ,, Jute, 180 lbs. rove ..	per ton	£14 10	£14 10	..
k Zinc, Sh't's. (Vielle Montagne ond.)	per ton	£23 2 6	£23 2 6	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

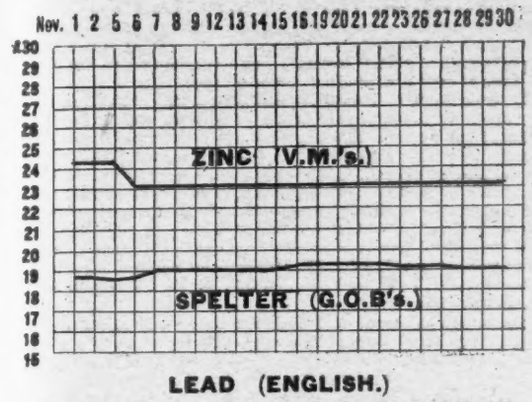
Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yeo & Co.

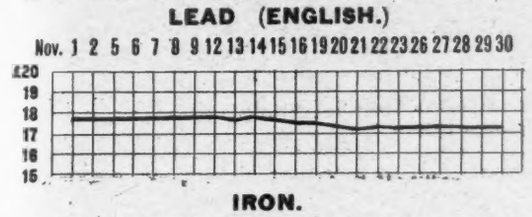
Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

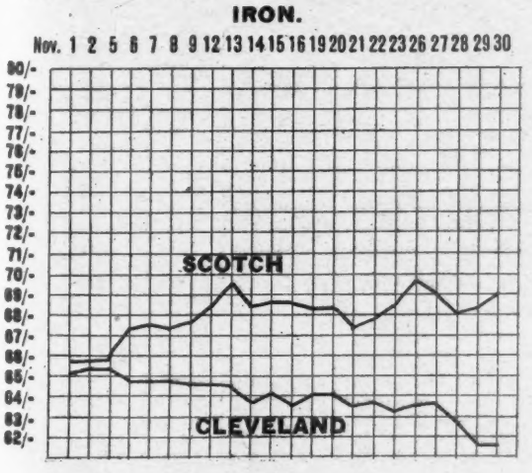
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

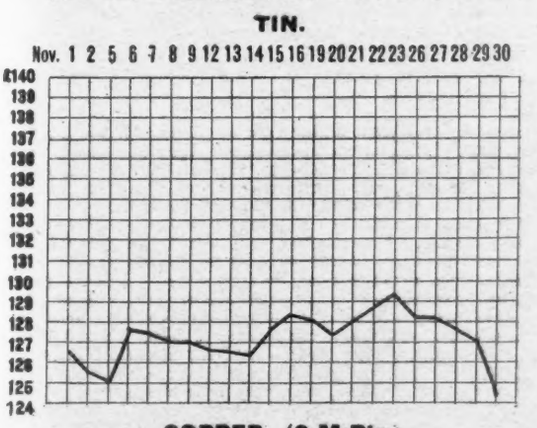
METAL MARKET.

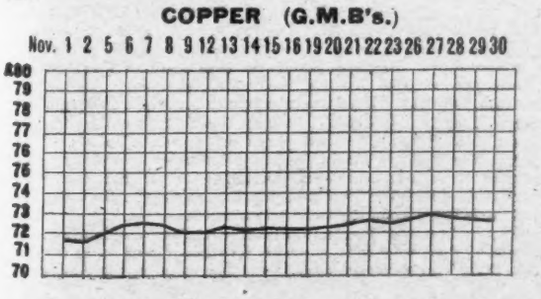
Fluctuations in November.











INSTITUTION OF ELECTRICAL ENGINEERS.

ON THE SUPERSESSION OF THE STEAM BY THE ELECTRIC LOCOMOTIVE.

By W. Langdon, Vice - President.

(Paper read November 29th, 1900.)

Probably one of the most interesting questions associated with the application of electrical energy to railway work is its eventual supersession of the steam locomotive. Electric locomotives of a capacity equal to that of the steam locomotive, doing similar work, and possessing certain marked advantages, are an accomplished fact, and to many it may seem that the days of the steam locomotive are numbered. We must not, however, forget that that which has been done has its *raison d'être*. Its employment has hitherto been generally confined to localities where the effects of steam and smoke would exercise a baneful influence. Because it has been so employed, and its employment has been attended with such marked success, it does not follow, however much it may appear desirable, that in overland lines of railway electricity will in future prove to be the element of power. Railways are commercial undertakings, in which vast sums of money have been embarked, all of which, investors expect, will produce a certain annual return. The supersession of steam by the electric locomotive thus resolves itself, primarily, into one of profit and loss. If its adoption will enable railways to be worked more economically than is the case under steam, then it will, with its attendant advantages, sooner or later, be adopted—if not by the whole, certainly by the greater portion of the railways of this country; but, whatever the ulterior advantages may be, unattended by this result, its adoption will remain doubtful.

The first question to be asked is: Are we in a position to consider the subject? Are the data at our disposal such as to admit of a reasonable treatment of it? I think so. The primary factors

Fig. 1.—London-Bedford Section (Midland Railway). Fig. 2.

are well known. We know how many pounds of steam we can obtain from a given quantity of coal. The efficiencies of prime movers and electrical generators, the loss in transmission, transformation, and distribution are all determinable. Any advantages yet to come must be looked for in the steam generator and in the simplification and consequent ultimate increase of efficiency in the electrical apparatus. In each, no doubt, the future will see production cheapened. Labour may advance, but competition will grow, and in the price of the manufactured article we may reasonably look to the future to produce some advantage.

Having then the material at hand, it is reasonable to conclude that the consideration of the subject can only be attended with good; for, if it should be shown that advantage is to be anticipated from such a change, it will help us to grasp that which has been

Quotations supplied by { c Messrs. Thos. Bolton & Sons. d Messrs. F. Wiggins & Sons. e Messrs. Frederick Smith & Co.

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Quotations supplied by { n Messrs. P. Ormiston & Sons. o Messrs. Johnson, Matthey & Co., Ltd. p The Phosphor Bronze Company, Ltd.

attempted, and perhaps to evolve from the data at our disposal the course most desirable to follow.

The railways of the United Kingdom comprised on December 31st, 1899,* the following mileage of line:—

Double line or more	11,977
Single line	9,723
Total mileage	21,700

The number of locomotives employed for working these railways was 20,461. The total number of vehicles of all descriptions was rendered as 752,930. The year's cost for locomotive power, including stationary engines, was £16,491,377. The number of miles travelled by trains was 396,241,265. Number of passengers—exclusive of season tickets—1,106,691,991. The tonnage of minerals, 296,611,190; and of general mechandise, 117,011,835.

In dealing with a question of this nature it seems desirable to produce these figures; but they are, in fact, of very little use, except to afford some idea of the magnitude of the subject. The length of the passenger journeys is not stated, nor are the journeys taken by season ticket holders included. To be of value the per passenger mileage, including, of course, the journeys made by season ticket holders should be given. The same objection applies to the mineral and goods tonnage statement. It records the tonnage declared as placed upon the railway, but whether it is carried one mile or one hundred miles is not shown. In fact, the returns, as rendered, aid the consideration of the subject very little; and I am sorry to say the information in the hands of the railway companies themselves carries us no further.

Under these circumstances, the establishment of a common basis upon which to consider the relative cost presents much difficulty. The only manner in which it can be approached is by averaging the data obtainable, or by examining the work of a particular section of line.

In Table I., I furnish extracts from the Board of Trade return for the year 1899, showing the mileage of line, cost of locomotive power, train mileage worked, &c., for England and Wales, Scotland and Ireland, together with certain deductions therefrom applicable to these results; also similar data in reference to six of the most important English companies.

In considering the mileage of line quoted, it should be mentioned that the figures do not disclose the *mileage of roads*. Over many sections of the several lines of railway there are more than two roads. Most main routes working out of London possess four, or even six roads, for a considerable distance; and the same applies to other busy portions of the chief railway systems.

The table indicated shows that the cost of locomotive power for the United Kingdom, including stationary engines for pumping and other purposes, works out at 9·988 pence per train mile; that the cost for England and Wales is 10·253; for Scotland 8·862; and for Ireland 8·104 pence. And that this cost varies with the several companies quoted as follows:—London and North-Western, 9·477 pence; London and South-Western, 9·844; Great Northern, 9·892; Great Western, 9·905; Midland, 10·218; and North-Eastern, 12·266—the average cost being 10·267.

Column *l* indicates the number of trains, per mile per hour, based upon the mileage of line of railway shown by the returns. Bearing in mind that there are, over many portions of the railways indicated, several lines, or roads, the number of trains travelling per mile per hour is, perhaps, surprisingly small. Ireland claims but 0·615; Scotland, 1·609; England and Wales, 2·505. Of the railways individualised, the Great Western has an average of but 2; the London South-Western and the North-Eastern each 2·2; London and North-Western, 2·9; Great Northern, 3·3; and the Midland, 3·7 (that is, the Midland for instance, has, on an average, 3·7 trains passing over each *mile of line of railway* each hour; not that the mile of line is occupied by these 3·7 trains during the entire hour, but that that is the average number of trains worked over the mile of line of railway—quite irrespective of the number of lines of rails—within that period of time).

If trains were, in practice, so distributed, this might form a basis on which to found a comparison of cost for the entire railway system; but we know that this is not so—that trains are much more frequent on certain portions and less frequent on other portions of the lines of railway, and although it is a kind of basis, affording some very interesting figures, it is not, as it stands, a practical one for the purpose in view. To effect this it is necessary to consider the work of an individual section of some line of railway; and with this view I have taken that portion of the Midland Company's main line between London (St. Pancras) and Bedford—omitting the suburban and local traffic applicable to the Metropolitan and Tottenham lines.

The length of line of railway is 49·5 miles—practically 50 miles; and the number of lines of rails applicable to the traffic under consideration may be taken as four—it is not less. In order to ascertain the number and character of trains to be taken into consideration, I have obtained returns (Tables II. and III.) extracted from the Block Book, of those trains passing two points—Luton and Harpenden—each hour, during a day of 24 hours in the month of July, 1900, which I have summarised and classified so as to bring the subject within reasonable scope. These details are carried forward to Table IV., which forms the basis of calculation for comparison of cost for power to work the traffic indicated.

The classification adopted is necessarily somewhat arbitrary, but in its construction I have endeavoured to err on the right side—for instance, I have debited each train of its class as a loaded train, whereas some would certainly be light trains. Again, I have, I believe, accorded to each their full merit of speed, although there is reason to assume that, in many instances, certain goods and minerals would not observe that allotted to them. From this table we get the tractive effort per train, and the consequent mechanical and electrical power required to deal with *one hour's work*. The work may, and, of course, does, vary from one hour to another; indeed, that is clearly shown by Tables II. and III.; for instance, the trains passing Harpenden vary per hour from 7 to 16, and Luton from 7 to 19, but the section of line chosen may be regarded as a full line, a line well occupied by trains both night and day, Sundays and week-days. The returns show an average of 11·9 trains passing Luton and of 12·4 passing Harpenden, per hour. In taking an average, however, I have apportioned no less than 14 trains to the hour. This number divided between the four lines of metals gives a result of 3·5 trains per mile per hour, per line of metals. It may here, however, be as well to point out that, so long as the appropriated number of trains is fairly that in practice, the number applied is, for comparison purposes, immaterial, for the comparison I draw is based upon the train mileage cost.

Fig. 1 illustrates the section of line under consideration. The position of engine sheds is shown by stars (*); of water cranes by dots (•). The short or suburban traffic between St. Pancras and

* Board of Trade Railway Returns, 1899.

Table I.—Mileage of Line, Cost of Locomotive Power, Train Mileage, &c.,
For Year Ending December 31st, 1899.

(a)	Length of line in miles open on December 31st, 1899. Double or more.	Single.	Total. (b)	Cost of locomotive power, including stationary engines. (c)	No. of locomotives. (d)	Number of miles travelled by trains. By passenger trains. (e)	By goods and minerals. (f)	Total. (g)	(h) Cost per train-mile for locomotive power. $\frac{c}{g}$	(k) Number of miles travelled by trains per hour during year of 365 days. $\frac{g}{8{,}760}$	(l) Number of trains per mile per hour (365 days to the year.) $\frac{k}{b}$
				£					Pence.		
England and Wales ...	9,933	5,111	15,044	14,101,842	17,411	178,684,803	151,377,966	330,062,769	10·253	37,678	2·505
Scotland	1,423	2,057	3,480	1,811,552	2,241	27,588,633	21,473,089	49,061,722	8·862	5,601	1·609
Ireland	621	2,555	3,176	577,983	809	10,367,617	6,749,157	17,116,774	8·104	1,954	0·615
Total—United Kingdom	11,977	9,723	21,700	16,401,377	20,461	216,641,053	179,600,212	396,241,265	9·988 Average.	45,233	2·084 Average.
Railway Companies.											
				£					Pence.		
Great Northern			825	995,690	1,259	11,729,522	12,426,497	24,156,019	9·892	2,757	3·3
Great Western			2,602	1,884,032	1,933	23,085,087	22,561,470	45,647,157	9·905	5,210	2·0
London and North-Western			1,924	1,927,049	2,959	26,285,278	22,515,697	48,800,975	9·477	5,570	2·9
London and South-Western			900	709,110	728	12,598,390	4,689,644	17,288,034	9·844	1,973	2·2
Midland			1,431	2,016,816	2,507	18,979,594	28,387,090	47,366,684	10·218	5,407	3·7
North-Eastern			1,632	1,632,967	2,047	14,641,572	17,307,802	31,949,374	12·266	3,647	2·2
									Average 10·267		

TABLE II.—LUTON.

Statement of the Number of Trains recorded in the Block Book for the 24 hours ending midnight on Thursday, July 19th, 1900.

Hours.	Express passenger.	Ordinary passenger.	Coaches.	Fish and milk.	Express goods. Class "A."	Express goods. Class "B."	Ordinary goods.	Minerals.	Light engines.	Total number of trains each hour.
12 to 1 a.m. ..	2	—	—	—	1	5	—	3	—	11
1 „ 2 „ ..	—	—	1	—	—	10	—	2	—	13
2 „ 3 „ ..	—	—	1	3	1	3	—	5	—	13
3 „ 4 „ ..	1	—	—	—	—	3	—	6	—	10
4 „ 5 „ ..	1	—	—	—	3	5	—	6	—	15
5 „ 6 „ ..	2	—	—	—	2	4	1	2	—	11
6 „ 7 „ ..	1	1	—	—	3	—	1	5	—	11
7 „ 8 „ .	1	1	4	—	2	4	1	3	—	16
8 „ 9 „ ..	1	1	—	—	1	2	—	2	—	7
9 „ 10 „ ..	4	—	—	—	—	2	—	4	—	10
10 „ 11 „ ..	4	1	—	—	—	1	1	4	—	11
11 „ 12 (noon)	3	—	—	—	1	1	1	3	—	9
12 „ 1 p.m. ..	4	1	—	—	—	1	2	5	—	13
1 „ 2 „ ..	4	1	1	—	—	2	—	4	—	12
2 „ 3 „ ..	6	2	3	—	—	—	—	8	—	19
3 „ 4 „ ..	2	3	—	—	1	—	3	5	—	14
4 „ 5 „ ..	4	—	1	—	—	—	1	5	—	11
5 „ 6 „ ..	4	2	—	—	—	—	2	3	—	11
6 „ 7 „ ..	5	1	—	—	—	—	—	4	—	10
7 „ 8 „ ..	4	2	1	—	—	—	—	5	—	12
8 „ 9 „ ..	—	2	1	—	3	—	—	1	—	7
9 „ 10 „ ..	2	—	—	—	1	2	—	4	—	9
10 „ 11 „ ..	5	2	—	—	—	—	2	7	—	16
11 „ 12 (midht.)	2	1	2	—	1	6	3	1	—	16

CLASSIFICATION.

Express passenger		62
Ordinary passenger	21	86
Coaches	15	
Fish and milk	3	
Express goods—Class "A."	20	74
„ „ Class "B."	51	
Ordinary goods	18	115
Minerals	97	
Total number of trains during the 24 hours ..		287
Maximum number of trains in 1 hour		16
Minimum „ „ „		7

TABLE III.—HARPENDEN.

Statement of the Number of Trains recorded in the Block Book for the 24 hours ending midnight on Thursday, July 19th, 1900.

Hours.	Express passenger.	Ordinary passenger.	Coaches.	Fish and milk.	Express goods. Class "A."	Express goods. Class "B."	Ordinary goods.	Minerals.	Light engines.	Total number of trains each hour.
12 to 1 a.m. ..	2	—	—	—	3	3	1	4	—	13
1 „ 2 „ ..	—	—	1	—	—	9	2	2	—	14
2 „ 3 „ ..	—	—	1	3	1	3	2	1	—	11
3 „ 4 „ ..	—	—	—	—	2	3	3	3	—	11
4 „ 5 „ ..	1	—	—	—	2	5	4	1	—	13
5 „ 6 „ ..	3	1	—	—	3	4	2	1	1	14
6 „ 7 „ ..	—	—	—	—	—	2	5	1	1	9
7 „ 8 „ ..	2	3	2	—	2	5	—	—	1	15
8 „ 9 „ ..	4	1	—	—	1	—	5	3	—	14
9 „ 10 „ ..	5	2	—	—	—	1	3	1	—	12
10 „ 11 „ ..	3	1	—	—	1	1	—	1	—	7
11 „ 12 (noon)	5	—	—	—	—	2	2	2	—	11
12 „ 1 p.m. ..	5	2	1	—	—	1	1	2	—	12
1 „ 2 „ ..	3	2	—	—	—	1	6	3	1	16
2 „ 3 „ ..	5	3	1	—	—	1	3	2	1	16
3 „ 4 „ ..	4	1	1	—	—	1	2	3	1	13
4 „ 5 „ ..	3	5	—	—	—	—	2	2	—	12
5 „ 6 „ ..	5	1	—	—	—	—	2	2	—	10
6 „ 7 „ ..	3	1	—	—	—	—	2	2	1	9
7 „ 8 „ ..	6	2	—	—	2	—	1	—	—	11
8 „ 9 „ ..	2	3	—	—	1	2	1	3	1	13
9 „ 10 „ ..	3	2	—	—	—	3	3	3	1	15
10 „ 11 „ ..	3	2	—	1	1	1	1	2	1	12
11 to 12 (midnt.)	—	1	1	—	4	4	2	2	—	14

CLASSIFICATION.

Express passenger		67
Ordinary passenger	33	41
Coaches	8	
Fish and milk	4	
Express goods—Class "A."	22	78
„ „ Class "B."	52	
Ordinary goods	55	
Minerals	46	111
Light engines	10	
Total number of trains during the 24 hours		297
Maximum number of trains in 1 hour		16
Minimum „ „ „		7

TABLE IV.—BASIS OF CALCULATION.

Showing Number of Trains, classified, passing certain points of a 50-mile Section of Line of Railway; calculated Mechanical Horse-power and Electrical power for working the same, together with apportioned speed, load, &c.

Class of train.	No. of trains per day of 24 hours passing. Luton.	Harpenden.	Basis of calculation. Apportioned No. of trains per hour.	Speed. Miles per hour.	Train miles per hour.	Load, including engine. Tons.	Total tractive effort per train.	Total. Mechanical H.P. per hour.	Equivalent in KW.-hours.	Mechanical H.P. per hour.	Equivalent in KW. per hour.
1. Express passenger	62	67	3	50	150	275	3,575	477	356	1,431	1,068
2. Ordinary passenger and empty coaches	36	41	2	32	64	300	2,130	182	136	364	272
3. Express goods and perishables	74	78	4	35	140	400	3,160	295	220	1,180	880
4. Ordinary goods and minerals	115	111	5	25	125	500	2,750	183	137	915	685
Totals	287	297	14		479					3,890	2,905
Average per hour	11·9	12·4									

* Tractive effort × load tons = total tractive effort per train.

$$\text{Tractive effort per ton} = 3 + \frac{v^2}{250} \text{ where } v = \text{speed in miles per hour.} \qquad \text{H.P.} = \frac{\text{tractive effort lbs.} \times \text{miles per hour.}}{375}$$

Hendon, and the Tottenham line, &c., is not included in my schedules, for the reason that, viewing the section of line as if actually subject to electrical working, there would be little doubt that this immediate London-Suburban traffic would demand a generating station nearer home than that indicated in the scheme I have adopted as my basis for the comparison of costs for working a 50-mile section of line.

The plant scheme is roughly outlined in fig. 2. Midway in the 50 miles of railway is the central station, containing four 2,500-KW., three-phase, or other characteristic, 10,000-volt generators. At this pressure current is distributed to sub-stations, each serving 10 miles of railway, where the potential is converted to 600, from whence it is carried to the contact rail. Or the centre 10-mile section may be provided for by direct-current generators served from the same steam plant.

The efficiencies of the various parts are assumed as follows:—

	Loss. Per cent.	Efficiency.
Motors	15	·85
Ohmic loss in rails	10	·90
Leakage	2½	·975
Rotary converters	10	·90
Static transformers	7	·93
H.T. transmission	10	·90

The total KW. required on the train wheels (Table IV.) is 2,905 per hour, and the number of trains is 14. Therefore $\left(\frac{2,905}{14}\right)$ 207·5 will be the average KW. per train hour; and, assuming the efficiency of the motors at 85 per cent. $\left(\frac{207·5}{·85}\right)$ 244 KW. will be the average power required to be supplied to each train. If now we allow 10 per cent. loss in the rails which supply and return the current, a pressure of 540 only will be available at either end of a section of 10 miles. Therefore the amperes per train that will be required will be $\left(\frac{244 \times 1,000}{540}\right)$ 452.

As there are 14 trains per hour in the total 50 miles section, there will be $\frac{14}{5} = 2·8$, say 3 trains in one section of 10 miles to be supplied by one sub-station.

$$452 \times 3 = 1,356 \text{ amperes.}$$

Adding 2½ per cent. for leakage, we have 1,390 amperes as the current to be supplied by each sub-station at 600 volts. The efficiency of the converters and static transformers is taken at,

respectively, 90 per cent. and 93 per cent., and the three-phase transmission at 90 per cent.

$$\therefore \frac{1{,}390 \times 600}{1{,}000 \times \cdot 9 \times \cdot 93 \times \cdot 9} = 1{,}107 \text{ KW. to be delivered to the}$$

trains for each section containing 3 trains.

As there are 14 trains, there will be four sections with 3 each, and one section with 2 trains.

Now the four sections with 3 trains each would require—

$$1{,}107 \times 4 = 4{,}428 \text{ KW.}$$

To allow for the maximum loss let it be assumed that the centre 10-mile section, which as previously indicated might be supplied direct at 600 volts, is so dealt with, and that is the section that has two trains only.

The KW. required would equal—

$$\frac{1{,}390 \times 600}{1{,}000} \times \frac{2}{3} = 556 \text{ KW.}$$

Therefore the total kilowatts to be generated would be—

$$(4{,}428 + 556) = 4{,}984, \text{ say } 5{,}000,$$

and the combined efficiency $\left(\frac{2{,}905}{4{,}984}\right)$ would be 58·3 per cent.

This 5,000 KW. is the power required to be generated to work the 14 trains, travelling 479 miles during the hour, as shown in Table IV., and upon it all comparative calculations and deductions have to be based.

The demand may, of course, go beyond this, or it may be less, but so long as the generating power, and that of the corresponding parts, is there to meet it, that branch of the question may be disregarded. As I have previously stated, the comparison is made between the ascertained quantities travelling a stated mileage at a stated speed. If the mileage were greater, or the number of trains greater, the comparison would be equally applicable. It is, in respect of the mileage result, immaterial, so long as we apply it to a fairly representative condition. The speed and the train load indicated in Table IV. will, I believe, bearing in mind that the number of trains are regarded as all carrying the full load indicated, be found to conform to this.

(To be continued.)

THE PARIS EXPOSITION OF 1900.*

By CARL HERING.

A LARGE international exhibition, like the one about to close, may be judged from two standpoints. For commercial reasons a necessary feature is its general attractiveness, that is, its beauty, architecturally, as well as in the arrangement of the grounds and in the decorations, its proper combination of instruction and entertainment and its purely entertaining features. On the other hand, such an exhibition should be a representation of what is called the state of the art in the various industries, and to a certain extent, at least, show the relative importance of competing industries.

From the first of these standpoints this exhibition may be said to have been a great success. It certainly was very beautiful and attractive, and in this respect it was typically French, for to the Frenchman such an exhibition would be a failure if it were not beautiful. While there were undoubtedly a few architectural features that might be criticised unfavourably, yet in general the buildings and arrangement of the grounds left little to be desired, although the absence of straight lines in the architectural decorations of the main buildings might not meet with the approval of every American, for in this respect they differ typically from those in the Chicago Exhibition. The arrangements and decorations of the characteristically unsightly interiors of long exhibition buildings were also very tasteful and effective, although the avoidance of a regular system of aisles made a systematic study of the Exhibition an almost hopeless task. In some of the attractions, such as the Optical Palace, the underground mines, &c., instruction and entertainment were combined, but as a rule, the too numerous "side shows" were for amusement only, and were typically French.

From the other standpoint, that of showing the state of the arts, the Exhibition may have been, and undoubtedly was, a success in many departments, but that claim can hardly be made for the electrical industry. For France, Germany, Switzerland, and a number of the other Continental countries, the electrical exhibits doubtless represented the true state of the art and the best general practice as far as these countries were concerned; but the absence of a proper representation from the United States, proportionate to the enormous development, made the Exhibition an incomplete representation of the present state of this important industry. Anyone judging its development in the respective countries by their exhibits would have obtained a very wrong impression of its progress in the United States, or of the general practice here. We sent over a few excellent electrical exhibits, and they were greatly admired, but there was general disappointment that a country in which the electrical industry is known to be so largely developed, was so inadequately represented. This is all the more unfortunate at the present time, when our export trade of manufactured articles is growing so rapidly, and when our electrical practice, in certain directions at least, is thought so well of by foreigners, that many of them come over here to study it.

The fact that several of our largest manufacturers have ceded their rights in foreign countries to local companies, and therefore claimed to have no interest there, may explain in part the absence of some of the important American electrical exhibits. But unfortunately these local companies do not always follow our practice, and do not manufacture the goods on the same scale and in the same way, so that their exhibits were not, as a rule, representative of our products.

England also was very inadequately represented in the electrical classes. The English claimed that they were tired of exhibitions, but another reason is no doubt the unfortunate political relation with France. England's exhibits in other groups also seemed to fail to represent the proper magnitude of the respective industries in that country.

Of all of those foreign to France, Germany, its former bitter enemy, had by far the finest exhibits in most of the groups, including the electrical. Another feature of interest, politically, is that Hungary had in many respects better exhibits than its stepmother country, Austria, and was represented as an independent nation; it bids fair to become one of the greater industrial countries of the East.

The question is frequently asked how the Paris Exposition compared with the one in Chicago in 1893. As both were very large and creditable, a comparison becomes difficult, and in order to give an opinion of any value one ought to have studied both equally thoroughly, and under equally favourable conditions. It is also largely a matter of individual taste, and depends on the nationality of the one giving it, as also on the extent of his knowledge of French. The area of the Paris Exhibition was 336 acres, which, together with the annex, made it about half as large in area as the fair in Chicago, which had about 1,000 acres. The average number of paid admissions seems to have been about double in Paris, due to the fact that it was so managed financially that the averaged admission was about 7 to 10 cents as compared with somewhat less than 50 cents at Chicago. Americans seem to have obtained their unfavourable views from antagonistic English papers.

It is thought safe to say that the Paris Exhibition, taken as a whole, was more generally beautiful in details, but that it contained no single group as magnificent as the famous Court of Honour, nor were the illumination effects as fine as at Chicago, where they were electrical, while in Paris gas was largely used, the whole of the largest open area, the Champ de Mars, being a brilliant mass of incandescent gas lamps. Neither had as finely illuminated fountains as the exhibition of 1889 in Paris, although the background to the poorly illuminated fountains in the present exhibition, forming the famous Chateau d'Eau, or Water Castle, was very beautiful and attractive.

The means of getting to and from the Exhibition were very poor, as Paris has unquestionably the worst managed tram and 'bus system of any large city in the world; its cab system, the best and cheapest of any large city, except, perhaps, London, was, of course, entirely inadequate and too expensive for the Exhibition traffic. The Exhibition, however, had the great advantage of being practically in the city itself, and in one which is admitted to be the most beautiful in the world, offering many attractions to visitors, and containing treasures which make it in itself an exhibition worth going to see. The Paris Exhibition was decidedly more truly international than the one in Chicago, and the social intercourse of those officially connected with it was for this as well as for other reasons, including the generous hospitality of the French, more interesting.

The electrical exhibit was greater in Chicago, where it filled a large separate building, while in Paris it was confined to a moderately small part of one of the buildings.

Among the classes of exhibits of well-developed industries there were three in particular which may be mentioned here specifically, as each marks a distinct and important direction of development, and was exhibited for the first time very prominently at a large international exhibition. They are the automobile, the incandescent gas lamp (known here as the Welsbach), and the three-phase generators, motors and systems. The automobile exhibit was very large, but, unfortunately for the electrical industry, it seems that the gasoline vehicle is gaining very fast in the race with the electric. In Paris, where automobiles are being used quite extensively, the quiet but heavy electric vehicle is seen only occasionally, while the light but noisy and malodorous one using gasoline is heard and smelt very frequently. The incandescent gas lamp was used in large numbers on the Champ de Mars, the only large open area in the exhibition, where arc lights would otherwise have been installed. Even the friends of the electric light must admit that the illumination produced by it was very effective, brilliant and white without being dazzling. This lamp is getting to be a very serious competitor to the electric light, and some of the European central stations, particularly in the home of its birth, Austria-Hungary, are having serious difficulty in competing with it. The third of these prominent classes of exhibits, the three-phase machinery, will be referred to below.

Another feature of indirect interest to the electricians is that most of the acetylene illumination was relegated by the authorities to two small strips of land unoccupied by any buildings along the banks of the river, which seems to indicate that acetylene illumination is limited to a narrow field of its own.

Much else might be said about the Exhibition in general, but we as electrical engineers, are more interested in the electrical exhibits. As was already mentioned above, these were representative of the state of the art only as far as the Continental countries were concerned, as those from the United States and England were very

* Inaugural address by the President at the 147th meeting of the American Institute of Electrical Engineers, New York, October 24th, 1900.

deficient in scope. It was also stated above that it was less of an electrical exhibition than the one at Chicago. There were, moreover, no quite novel, epoch-making electrical inventions shown, although a few quite interesting ones that were already known to readers of the electrical journals, were exhibited there for the first time. Detailed descriptions of all the important apparatus have doubtless been or will be given, in the electrical journals, where they more properly belong, and where they can be read at one's leisure, and therefore no attempt will be made here to give such descriptions, even if time permitted, the intention being merely to mention some of the chief features and to make some general observations.

One of the striking features was the great prominence of three-phase generators, and their size. One obtains the impression that the three-phase current has triumphed over all the others, including the continuous current, when large amounts of power are concerned, and that it would be poor practice now to instal large units of any but the three-phase system unless one is forced to use another. There was shown a decided tendency toward the use of large units, and quite a number were exhibited having outputs of about 1,000 KW. and over. The greater number were for three-phase currents, and all formed the fly-wheel of their direct-connected slow-speed engines, while all of the few large continuous current machines exhibited had to have a separate fly-wheel. That the field is made the revolving part seems to be almost universal practice, as also the distributed winding on the armature. Single and two-phase alternators and large continuous current machines were the exception.

Two very ingenious attempts were shown to compound large three-phase generators without commutating the main current, one by Hutin and Leblanc and the other by Boucherot. Both excite their direct current and mechanically coupled exciter by means of the three-phase alternating current, the exciter therefore having a revolving field, but fixed brushes; in both the excitation of the exciter is dependent on the voltage of the alternator and on the main current, in the former by means of a shunt and series field magnet coil, and in the latter by means of a transformer combining the effects of both. To obtain direct current from such an exciter, the connections between the commutator and the coils in the former are reversed according to a certain law; while in the latter the armature has several windings differing in their number of turns according to a sine law. Both claim to keep the voltage of the generator constant for different currents and load factors. It will be noticed that there is no commutation except that of the small exciting current in the direct current exciter. Whether they are better or worse than the commutating systems used here, practice alone can decide. While they are interesting studies, it does not yet seem to be proved that for large units, at least, a cheaper attendant than these would require, with his hand on the rheostat and his eyes on the voltmeter, is not a more practical solution.

The amortisseur of Hutin and Leblanc, consisting of a short-circuited cage through the poles of the magnets, for facilitating parallel running, seems to be meeting with some favour, and is being commented upon very favourably.

The largest generator exhibited was a 72-pole 3,000-KW. three-phase machine, of the Allgemeine Elektricitäts Gesellschaft of Berlin. Its speed was 83, frequency 100, voltage 6,000, weight about 160 tons, and diameter of revolving field about 24 feet. As many as 21 of these are under construction. It was claimed to be the largest in the world, but this is an error, as generators of 4,000 KW. and over are in use in this country at even slower speeds. Several others above 1,000 KW. were shown, the slowest speed being 72, of the 2,700-KW. mixed single and three-phase current Helios machine.

The direct generated voltages of the three-phase machines was from 2,000 to 6,000 volts; there was one exhibit of a comparatively small generator for 30,000 volts, but as long as good transformers can be bought, such excessively high voltage machines will probably be used only for exhibitions and lavatories.

There were a number of inductor alternators exhibited, which indicates that they are meeting with some favour.

Connecting lamp circuits to three-phase generators does not seem to be considered a sufficiently serious matter to overbalance the advantages of that system. The method used by the General Electric Company, of Berlin (that is, the Allgemeine Elektricitäts Gesellschaft, which, even in Germany, is generally abbreviated to A.E.G.) is simply to distribute the lights as evenly as possible over the three branches. All three mains are run into the buildings of even small consumers, although only two may be used, the third being available for changing over a batch of lamps, if necessary, for balancing. The voltage can thus be regulated only for all three branches together, and not for each separately; but this is not considered a serious disadvantage. The Oerlikon Company, on the other hand, connects lamp circuits between the ends of only two of the three branches of a star-connected winding, the third branch being then idle; this enables the voltage of that single-phase alternating current circuit to be regulated at the machine. By overloading these two circuits 15 per cent., the capacity of the generator is about the same as for motor circuits with a power factor of 0·8. The units in a station can then be alike, and it does not interfere with paralleling, or running motors and lights from the same machine if necessary. Another method used in Switzerland, but only with two-phase generators, is to construct a sort of double machine, the two halves of which may be mechanically displaced relatively to each other to generate two-phase currents for power purposes, or they may be connected in line with each other to generate single-phase currents for lighting.

(To be continued.)

PHYSICAL SOCIETY.

Ordinary Meeting held November 23rd.

Prof. Everett, F.R.S., Vice-President, in the Chair.

A paper on "A Self-Adjusting Wheatstone Bridge," by E. H. Griffiths and W. C. D. Whetham, was read by Mr. Whetham.

The object of this paper is to describe a cheap and easy method of getting a self-adjusting bridge to show on a scale the actual resistance of any wire. Contact with the bridge wire is made by means of a light horizontal bar, which is suspended by a phosphor bronze strip from the coil of the d'Arsonval galvanometer used with the instrument; a second bar, parallel to, and above the first, is rigidly connected with the coil. A wooden beam, worked by clockwork, moves up and down between the bars and clamps them alternately. When the beam is down, contact is made with the bridge wire. If this contact is not at the zero point a current will flow through the coil, and if the cell is connected up the proper way, it will turn the coil so as to bring the upper bar nearer to the null point. This puts a twist into the phosphor bronze strip, and when the beam rises and clamps the upper bar, the torsion comes into play and brings the lower bar under the upper one. The beam then descends and makes contact at this point, and if any current flows through the galvanometer there is further movement until the null point is reached. Any alteration in the resistance of the wire under experiment causes a movement of the zero point on the bridge wire, and this is followed by the lower arm. The position of the lower arm can be directly indicated by means of a scale.

Prof. S. P. Thompson asked how the scale was calibrated.

Mr. Whetham said the scale was arbitrary, but it could be calibrated by the known resistance of the bridge wire per unit length. Extension of the range can be obtained by shunting the bridge wire with various resistances.

Mr. Glazebrook asked how sensitive the bridge was.

Mr. Whetham said that working with a dry cell, it could easily indicate one degree on a platinum thermometer.

Mr. Blakesley pointed out that if the cell was connected up the wrong way the zero point would be an unstable one.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1900.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester and Birmingham, to whom all inquiries should be addressed.

20,858. "Improvements in and relating to arc lamps for projection purposes." C. V. Drysdale. Dated November 19th.

20,868. "Improvements in electric lamps for use in photography." J. Schmidt. Dated November 19th.

20,870. "Improvements in electrical signalling for railways." H. H. Lake. (L. Olper, Italy.) Dated November 19th.

20,873. "Improvements in the manufacture of carbons for electrical and other purposes." H. R. Gregory. Dated November 19th.

20,878. "Improvements in telegraphic receiving and translating arrangements." A. Muirhead. Dated November 19th.

20,879. "Improved construction of coin-freed apparatus for receiving and delivering letters, telegrams, and the like," J. T. Scott. Dated November 19th.

20,926. "Improvements in electric arc lamps." Crompton & Co., Ltd., S. L. Brunton and A. J. Hodgson. Dated November 20th. (Complete.)

20,931. "An improved method of illuminating dining tables and the like by electricity," H. E. Evans. Dated November 20th.

20,942. "Improvements in systems of motor control." The British Thomson-Houston Company, Limited. (W. B. Potter, United States.) Dated November 20th. (Complete.)

20,943. "Improvements in safety devices for electric motor control systems." The British Thomson-Houston Company, Limited. (M. W. Day, United States.) Dated November 20th. (Complete.)

20,945. "Improvements in electric telegraphs." C. Adams-Randall. Dated November 20th.

20,946. "Improvements in electric telephony." C. Adams-Randall. Dated November 20th.

20,960. "Reversible galvanic cells or so-called storage batteries." T. A. Edison. Dated November 20th. (Complete.)

20,961. "Improvements in electric cables." D. Cook. Dated November 20th.

20,967. "Improvements relating to incandescent electric lamps." H. H. Lake. (W. P. Pinckard, United States.) Dated November 20th.

20,989. "Improved construction of electric meter." F. Moore. Dated November 20th.

20,995. "Improvements in poles for electric railways, electric lights and telephone and telegraph lines," E. W. Serrell. Dated November 21st. (Complete.)

21,004. "Improvements in primary batteries." R. F. Hall. Dated November 21st.

21,017 "Improvements in typewriters and in the printing telegraphs." J. D. White. Dated November 21st.

21,023. "Improvements relating to the excitation of the field magnets of electric generators and electric motors." J. R. Blaikie. Dated November 21st.

21,025. "Improvements in electric railway systems and switches therefor." The British Thomson-Houston Company, Limited. (F. W. Hild, United States.) Dated November 21st. (Complete.)

21,026. "Improvements in electric railway systems." The British Thomson-Houston Company, Limited. (W. B. Potter, United States.) Dated November 21st. (Complete.)

21,027. "Improvements in ground detectors for electric circuits." The British Thomson-Houston Company, Limited. (W. H. Pratt, United States.) Dated November 21st. (Complete.)

21,028. "Improvements in electric railways." The British Thomson-Houston Company, Limited. (P. Farnsworth, United States.) Dated November 21st. (Complete.)

21,029 "Improvements in tachometers." The British Thomson-Houston Company, Limited. (C. D. Haskins, United States.) Dated November 21st. (Complete.)

21,030. "Improvements in electric railways." The British Thomson-Houston Company, Limited. (W. B. Potter, United States.) Dated November 21st. (Complete.)

21,031. "Improvements in systems of electric motor control." The British Thomson-Houston Company, Limited. (A. H. Armstrong, United States.) Dated November 21st. (Complete.)

21,036. "Improvements in switches for electric lamps and the like." H. M. Salmony. Dated November 21st.

21,0 2. "Improvements in electric arc lamp carbons." T. A. Rose and A. Barnes. Dated November 21st.

21,086. "Improvements in electric ceiling roses for suspended and like fittings." G. Sperryn and W. H. Wood. Dated November 22nd

21 100. "Improvements in or applicable to electric converters or transformers." J. P. Hall. Dated November 22nd.

21,135 "Improvements in the manufacture of plates for secondary batteries." T. Pescatore and The Tudor Accumulator Company, Limited. Dated November 22 d.

21,149. "Electrolytic process for the precipitation of metals and alloys from their solutions, as also for the deposition of metals or alloys on other metals or alloys, or on other substances." J. Meurant. Dated November 22nd. (Complete.)

21,179. "Improvements in tel phone switch jacks." A. Whalley. Dated November 23rd.

21,180. "An excess electric current indicator controller and cut-out." P. J. Pringle. Dated November 23rd.

21,182. "Improvements in gas pendants chandeliers, electroliers and the like." M. F. Hawkes. (Thrift and Enterprise Company.) Dated November 23rd.

21,196. "Improvements in marine and electric light fixtures and switches therefor." G. L. Martin. Dated November 23rd.

21,216. "Improvements in method of graphitizing electrodes." P. M. Justice. (The International Acheson Graphite Company, United States.) Dated November 23rd. (Complete.)

21,217. "Improvements in current regulators." P. M. Justice. (The Erie Exploration Company, United States.) Dated November 23rd. (Complete.)

21,228. "Improvements in or relating to electrodes or the wires or conductors connected thereto in electrolytic cells, meters, or other electrolytic apparatus." The Bastian Meter Company, Limited, and C. O. Bastain. Dated November 23rd.

21,233. "Improvements in secondary batteries." T. Pescatore and The Tudor Accumulator Company, Limited. Dated November 23rd.

21,252. "Improved means of eliminating and retarding certain electric and other rays for surgical, medical and other purposes." C. M. Johnson. Dated November 24th.

21,255. "Improvements in the methods of jointing electrical conductors." C. V. de Falbe (trading as the Electrical and General Contracting Company.) Dated November 24th.

21,292. "Improvements in means for obtaining magnetic adhesion of locomotives or motor cars in electric railways." The British Thomson-Houston Company, Limited. (The Union Elektricitäts-Gesellschaft, Germany.) Dated November 24th. (Complete.)

21,293. "Improvements in insulated electric conductor and method of making the same." The British Thomson-Houston Company, Limited. (C. P. Steinmetz, United States.) Dated November 24th. (Complete.)

21,294. "Improvements in systems of electrical distribution." The British Thomson-Houston Company, Limited. (C. P. Steinmetz, United States.) Dated November 24th. (Complete.)

21,304. "Improvements relating to electric meters." F. Lux. Dated November 24th. (Complete.)

21,311. "Improvements relating to electric traction." H. C. King. Dated November 24th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

513. "An improved electro-mechanical system for providing additional security for safes, vaults, and similar receptacles, for the storing of valuables." F. Freed, I. Freed, D. K. Clink, and G. J. Reed. Dated January 9th, 1899. Relates to an improved electro-mechanical protection system, and the object is to provide a certain infallible means for giving warning upon an improper attempt being made to gain access to the valuables. Consists in the construction, combination, and arrangement of the several elements comprising an auxiliary protection system independent of the security afforded by the receptacle. 9 claims.

2,629. "Improvements in the electrolysis or electrical treatment of gases and gaseous mixtures or compounds." R. J. Yarnold. Dated February 6th, 1899. Consists of apparatus characterised by being formed with two outside or covering conductors (respectively connected with the source of electric energy) the space between which is divided by a compilation of respectively insulated dielectrics into a series of through channels in such a manner that each adjacent pair of dielectrics forms and is separated by one of the said channels, and that each of the channels is bounded at its side only by the insulators. 1 claim.

5,838. "Elevator and transfer crane for storage batteries." G. H. Condict. Dated March 17th, 1899. (Date applied for under Patents, &c., Act, 1883, Sec. 103, September 3rd, 1898, being date of application in United States.) The invention includes the combination with a travelling overhead crane of a number of small elevators, each of which is equipped to pick up and carry a tray of batteries wherever desired within the line of travel of the crane in connection with rows of charging tables corresponding with the elevators. 7 claims.

6,125. "Improvements in electrically-operated road vehicles." P. M. Justice. (The Pope Manufacturing Co. Incor., United States.) Dated March 21st, 1899. Consists in the combination of the body, battery boxes supported by said body and having each of its terminals unsymmetrically disposed thereon and connections secured to the body and having loose ends of unequal length. 4 claims.

6,125a. "Improvements in and relating to storage batteries." P. M. Justice. (The Pope Manufacturing Company (Incor.) United States.) Dated March 20th, 1899. Consists of means for connecting various portions of the apparatus and of connecting the batteries to the supply cable with a view to guarding against the possibility of improper connection and to the provisions for recharging with a view to effecting automatically the interruption of the supply when the batteries are fully charged. 4 claims.

8,045. "Improvements in and relating to the manufacture of armoured electric cables." E. T. Greenfield. Dated April 17th, 1899. (Date applied for under Patents, &c., Act, 1883, Sec. 103, December 15th, 1898, being date of application in United States.) Consists of a machine for armouring electric cables by continuously forcing strips of metal into suitably-shaped dies through which the cable to be armoured is caused to pass longitudinally while being revolved whereby strips of metal are spirally formed and at the same time applied to the cable. The machine comprises three main groups of contrivances, viz., one for feeding the unarmoured cable through the machine, another for spirally forming and applying the armour, and a third for reeling or winding up the armoured cable. The rate at which these all work is regulated by the speed of the second operation. 9 claims.

8,172. "Improvements in electric railways on the closed conduit or like systems." H. S. Cox. Dated April 18th, 1899. Consists of a safety electric cable railway system for a double track comprising live line conductors for the tracks respectively arranged in closed insulated conduits having exposed conducting sections normally electrically dead, a single main, feed conductor insulated and having lateral feeder connections at intervals to both line conductors, generators for said tracks respectively, each having its track return connected thereto and both generators connected with the single main feed conductor. 9 claims.

8,325. "Improvements in electric railways working on the surface contact system." R. Lundell. Dated April 20th, 1899. Relates to electric railways and has for its object (1) to provide simple and efficient means for effecting the connection between the sectional service conductor and the current feeder or main; (2) to insulate the operative parts from the surface of the road; (3) to avoid possible actuation of the switching electro-magnet through leakage. These are effected by and through the agency of a series of magnetically controlled relays located in air and watertight switch boxes embedded in the road bed and adapted to control the current flow from the current feeder or main to the branch feeders and sectional service conductors by electro-magnetic switching devices actuated by an independent circuit preferably of low voltage, the arms of the relays being controlled in their movements by a powerful magnetic field carried beneath the cars and over the relays. 3 claims.

8,498. "Improvements in electric elevators." E. H. Johnson. (G. Rennerfelt, United States.) Dated April 22nd, 1899. Consists of an electric motor provided with electro-magnetic means for automatically closing the circuit through the field-magnet coils before it is closed through the armature coils in combination with additional electro-magnetic means for effecting such closure of the circuit through the armature coils. 8 claims.

10,476. "Improvements in reflectors and shade holders and reflectors for electric and gas lamps." J. Houbois. Dated May 18th, 1899. Consists of a mounting for reflectors in which the inner and outer parts are screwed into each other and in which the one electrical connection is made by means of the contact of the parts of the mounting and the other connection by means of a suitable contact such as a pin screw or the like. 8 claims.

11,010. "A waterproof lampholder for Swan incandescent electric lamps." H. D. Fitzpatrick. (G. Brandt.) Dated May 26th, 1899. Consists of a holder for Swan incandescent electric lamps shaped like a double cap insulator and made of porcelain or other insulating and fire resisting material, said holder being so made that all the conducting parts are insulated from one another by a portion of the material of the holder itself. 4 claims.

11,070. "Improvements in apparatus for making lead battery plates." C. A. Gould. Dated May 27th, 1899. Consists in the provision of means for preventing, as far as possible, deflection or bending of the spanning knives where they enter the plate. For this purpose it is preferred to form the washers which are interposed between the knives on the rolls of sufficient diameter to extend almost into contact with the grid plate when the knives are fully inserted. In addition it is preferred to provide special knife separating means independent of the rolls interposed between the knives and separating and guiding same where they enter the plate. 14 claims.

11,348. "Improvements in electrodes or plates for secondary batteries." L. G. Loffler. Dated May 31st, 1899. Each positive plate consists of a solid lead core having on both sides horizontal ribs which stop short of the edges of the plate and also projections formed on the edges of the plate. The negative plates differ from the positive plates only by having in the core perforations arranged between the ribs at regular intervals for allowing the electrolyte to pass from one side to the other. 3 claims.

11,426. "An improved electro-magnetic device for use in connection with the propulsion and steering of ships and for similar purposes." D. Bacon. Dated June 1st, 1899. The rotation of the engine shaft is caused to be communicated to the shaft which operates the propeller and to the steering shaft through the medium of electro-magnetic power transmitting devices. 8 claims.

12,297. "Improved means for controlling electric motors, the invention being particularly adapted to the motors of elevators." Otis Elevator Co., Ltd. (Otis Bros. and Co. Incor., United States.) Dated June 13th, 1899. Consists of a switch device controlling the circuits of the motor and an operating circuit for said switch device including circuit controllers whereby the movements of the alternating current motor can be controlled by operating said controllers. Also includes a novel governor and brake device. 19 claims.

12,635. "Electric motor." E. S. Halsey. Dated June 17th, 1899. Consists of a set of wheel train counters driven by a small motor through which the current to be measured passes of a definite part thereof, and the speed of rotation of said motor is in direct keeping with the amount of current passing through it. The motor consists of a constant magnetic field. In this field rotates an armature consisting of a continuous piece of copper wire and carried by a vertical shaft which is geared through a worm, to the recording mechanism at its upper end; but a small part of the armature lies within the magnetic field at one time; the current is led to the armature by two small electrodes that dip into mercury in which the armature is submerged, at opposite borders of the field so that the current will have to travel the whole length of the field. 4 claims.

12,706. "Electric muscular exerciser." A. B. Macmillan. Dated June 19th, 1899. The object of the invention is to provide for the passage of an electric current or succession of electric shock through the portions of the body of a person using the apparatus. In carrying out the invention the straps or cords, which are attached to weights or elastic bands are passed over pulleys one of which imparts rotation to a small magneto-generator and suitable electric connections between the terminals of the generator and the handles of the apparatus are made. 8 claims.

12,869. "Improvements in driving mechanism for dynamo and other machines." W. L. Bliss. Dated June 20th, 1899. Relates to means suitable for driving a dynamo from the axle of a car. The motion is communicated from the axle to the wheel which drives the armature pinion or pulley, through a flexible driving connection which transmits only the rotative component of the axle motion, all other components being lost. The dynamos mounted on the car thus avoiding shock, &c., which the axle gets and does not put any of its weight on the axles. 12 claims.

13,526. "Improvements in rail bonds for electric railways." A. J. Boult. (F. H. Daniels, United States.) Dated June 29th, 1899. The wire rope connection of a rail bond of that type in which the bond proper or connector between the two terminals consists of strands of copper wire twisted together. At a point between its ends or between the terminals, the bond bulges and has its strands loosened and spread apart. 2 claims.

13,570. "Improvements in electric generators for gas engine lighters." B. Molinnerney. Dated June 30th, 1899. In the generator is a horse-shoe permanent magnet with laminated wire wound poles and a keeper and means for carrying one past the other to first reduce the magnetic flux and then increase it suddenly to a maximum. 10 claims.

14,216. "Improvements relating to electric railways and tramways on a road contact system." J. Witter. (The Elektricitäts Aktien-Gesellschaft vormals Schuckert and Co., Germany.) Dated July 10th 1899. Relates to a system of electric railway with sectional conductors and relays in which the sectional conductors are switched on and off by means of relays controlled by the passing vehicle, and in which the relays may be reversed in groups according to the direction in which the vehicle is desired to move, this reversal being effected by hand or automatically. 3 claims.

15,146. "Improvements in junction boxes for underground electric conductors." Siemens Bros. & Co., Ltd. (Siemens & Halske Aktien Gesellschaft, Germany.) Dated July 22nd, 1899. Relates to means of providing against the rush of short-circuiting by enclosing the junction portions of two or more adjacent conductors in separate compartment of the junction box having openings provided with covers so arranged that when access is given to one the opening of the others are necessarily closed. 1 claim.